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Atherosclerotic pattern of coronary myocardial bridging assessed with CT coronary angiography

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Abstract The aim of our study was to evaluate the atherosclerotic pattern of patients with coronary myocardial bridging (MB) by means of CT Coronary Angiography (CT-CA). 254 consecutive patients (166 male, mean age 58.6 ± 10.3) who underwent 64-slice CT-CA according to current clinical indications were reviewed for the presence of MB and concomitant segmental atherosclerotic pattern. Coronary plaques were assessed in all patients enrolled. 73 patients (29%) presented single (90%) or multiple (10%) MB, frequently (93%) localized in the mid-distal left anterior descending artery. The MB segment was always free of atherosclerosis. Segments proximal to the MB presented: no atherosclerotic disease ($n = 37$), positive remodeling ($n = 23$), <50% ($n = 14$), or >50% stenoses ($n = 7$). Distal segments presented a different atherosclerosis pattern ($P < 0.0001$): absence of disease ($n = 73$), no significant lesions ($n = 8$). No significant differences were found between segments proximal to MB and proximal coronary segments apart from left main trunk. Pattern of atherosclerotic lesions located in segments 6 and 7 significantly differs between patients with MB and patients without MB ($P < 0.05$). CT-CA is a reliable method to non-invasively demonstrate MB and related atherosclerotic pattern. CT-CA provides new insight regarding atherosclerosis distribution in segments close to MB.

Keywords Multislice computed tomography · Coronary angiography · Coronary anomalies · Myocardial bridging · Coronary artery disease

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Introduction

Coronary artery myocardial bridging (MB) is a congenital anatomical variant of the coronary arteries in which a segment of a major epicardial coronary artery, frequently the left anterior descending artery (LAD), partially or entirely courses within the myocardium [1]. It can be characterised by systolic compression of the tunnelled segment and may cause angina, myocardial ischemia, myocardial infarction,

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left ventricular dysfunction, paroxysmal AV blockade, as well as exercise-induced ischemia [2]. However, MB is asymptomatic in the majority of cases [2]. The coronary segment proximal to the MB frequently shows atherosclerotic plaque formation, although the tunnelled segment is typically spared [3].

Conventional coronary angiography (CCA) has been denoted as the reference standard to diagnose MB with the systolic compression ("milking effect"). A large discrepancy exists between pathological series, with a varying incidence from 5 to 86%, and angiographic series, with a varying incidence from 0.5 to 33% [1]. This wide variability may be due to the definition of MB and to the modality used for the assessment. Novel imaging techniques, such as invasive Intravascular Ultrasound (IVUS) or Intracoronary Doppler (ICD), have been employed for the assessment of MB [4, 5]. CT Coronary Angiography (CT-CA) allows the detection of significant coronary artery stenoses and provides a valid alternative to CCA in selected patient populations [6, 7]. Recent studies demonstrated that MB may be displayed with 16- and 64-slice CT-CA [8–18] and that proximal atherosclerotic lesions could be associated [19]. In our study, a population of patients who underwent CT-CA according to current clinical indications [6, 7] was reviewed for the presence of MB and segmental atherosclerotic pattern. The aim of our study was to find evidence of MB influence on coronary atherosclerosis distribution providing a comparison with a clinically similar group of patients without MB by means of CT-CA.

Materials and methods

Population

We retrospectively enrolled 254 consecutive patients (166 male, mean age 58.6 ± 10.3) who underwent 64-slice CT-CA at our department from September 2006 to April 2008 for suspected coronary artery disease (CAD) according to current clinical guidelines (Table 1) [6, 7]. Patients with known CAD (coronary revascularization by either cardiac surgery or angioplasty) were excluded from the study. Usual inclusion (sinus cardiac rhythm <70 bpm, ability to maintain breath-hold for at least 15 s) and exclusion (previous allergic reaction to iodine contrast medium, renal insufficiency with creatinine clearance <60 ml/min, pregnancy, respiratory impairment, unstable clinical status) criteria for 64-slice CT-CA were adopted. Patients with heart rate ≥65 bpm (without known contraindications to β-blockers such as asthma, bronchospasm, systolic blood pressure <100 mmHg)

Table 1 Patients characteristics

	MB (%)	No MB (%)	All (%)
Patients	73 (29)	181 (71)	254
Male	46 (63)	120 (66)	166 (65)
Female	27 (37)	61 (34)	88 (35)
Age (mean ± SD)	58.4 ± 10.6	58.7 ± 10.2	58.6 ± 10.3
Diabetes	16 (22)	35 (19)	51 (20)
Smokers	32 (44)	83 (46)	115 (45)
Dyslipidemia	45 (62)	98 (54)	143 (56)
Hypertension	58 (79)	138 (76)	196 (77)
Family history	40 (55)	93 (51)	133 (52)
Obesity	39 (53)	86 (48)	125 (49)
Atypical chest pain	41 (56)	87 (48)	128 (50)
Typical chest pain	8 (11)	29 (16)	37 (15)
High-risk individuals	16 (22)	38 (21)	54 (21)
Ascending aorta evaluation	8 (11)	27 (15)	35 (14)
Negative ECG-stress test	31 (42)	114 (63)	145 (57)
Equivocal ECG-stress test	38 (52)	46 (25)	84 (33)
Positive ECG-stress test	4 (6)	21 (12)	25 (10)

MB coronary artery myocardial bridging

No significant differences were found between two groups ($P > 0.05$) apart from ECG-stress test findings ($P = 0.0002$)

received 20–40 mg of propranolol (Inderal, AstraZeneca Reims, Reims, Cedex, France) orally 30 min prior to the examination in order to improve image quality. No nitroglycerin was administered in the present population.

Patients were reviewed for the presence of MB and segmental atherosclerosis. The Institutional Review Board approved the study protocol and informed consent was obtained from all patients.

CT scan and reconstruction parameters

All examinations were performed with a 64-slice CT scanner (Brilliance 64, Philips Medical Systems, Cleveland, Ohio, US) with the following parameters: slices/collimation 64/0.6 mm, rotation time 420 ms, effective temporal resolution (with 180° algorithm) 210 ms, 120 kV, 900–1040 mAs, table feed/s 11.9 mm, field of view 140–180 mm (140–240 mm in patients evaluated for suspected ascending aorta aneurysm), sub-millimeter isotropic voxel resolution, effective slice thickness 0.8 mm, reconstruction increment 0.4 mm, medium (CB) and sharp (CC) convolution filters.

A bolus of 100 ml of high-iodinated contrast material (400 mg/ml iomeprol, Iomeron 400, Bracco, Milan, Italy) was injected into an antecubital vein of the right arm with a flow rate of 5 ml/s. A bolus-tracking technique with a region of interest at the level of the ascending aorta (delay 8 s; threshold 150HU) was used for the synchronization between arterial passage of contrast material and CT-CA scan.

To obtain optimal image quality, data sets were reconstructed at two points or more of the cardiac cycle by using a retrospective ECG-gating algorithm (end-diastolic phases from 65 to 75% and end-systolic phases at 40–45% of the R-R interval).

Image and data analysis

All examinations were reviewed by two experienced radiologists with a level 3 expertise in cardiac CT [20], using a dedicated workstation (Extended Brilliance™ Workspace, Version 3.0.1.3200, Philips Medical Systems, Cleveland, Ohio, US). A total number of 258 examinations were performed and only 4 scans (1.5%) were initially excluded from the cohort by the readers due to poor image quality. In total, 87 segments (2.2%) were not evaluated due to high heart rate during the scan, breathing artifacts or small dimensions of more distal vessels.

All data were analysed with conventional post-processing tools, namely: cross-sectional imaging, multiplanar reconstructions (MPR), curved MPR (cMPR), maximum intensity projections (MIP), and volume rendering (VR) to display MB and local/total atherosclerotic lesions. Segments were classified according to the 16-segments American Heart Association (AHA) classification scheme [21]. Location, length (<1, 1–2, and >2 cm), and depth of MB were determined. Depth was defined as superficial (epicardial vessel partially surrounded by myocardial wall; no deviation of the MB) or deep (epicardial vessel completely surrounded by myocardial wall; U-shaped curve into the myocardium of the tunnelled segment).

Segments proximal and distal to the MB were assessed for the presence of vessel positive remodeling, ≤50%, and >50% stenoses. Atherosclerotic plaque composition was also evaluated with a qualitative approach. Calcified plaques were defined as high-density lesions and non-calcified plaques as soft tissue-density lesions that were clearly distinguishable from the adjacent epicardial fat and the lumen. Plaques were classified as mixed when both elements were detected within a single plaque [22, 23]. Positive remodeling was defined as not-stenotic thickening of vessel wall with outward expansion of not calcified plaque. Coronary plaques were assessed in all patients enrolled.

Statistical analysis

Patients characteristics in the two groups (i.e. patients with/without MB) were compared with Fisher's exact test ($P < 0.05$). Age was compared using Welch's T test ($P < 0.05$). A chi-square test was performed to analyze the statistical difference regarding atherosclerosis distribution between proximal and distal segments to the MB ($P < 0.0001$). Characteristics of patients with MB free of concomitant atherosclerosis were compared with those of patients with concomitant atherosclerosis using Fisher's exact test ($P < 0.0001$). Segmental proximal atherosclerosis was compared with AHA 16-segments using chi-square test ($P < 0.05$). An intersegmental comparison between patients with MB and patients without MB was performed using chi-square test

($P < 0.05$). Statistical evaluation was performed with dedicated software (SPSS 10.1; SPSS, Chicago, US).

Results

73 patients (29%, 46 male, mean age 58.4 ± 10.6 years, mean heart rate 62 ± 9 bpm; see Table 1) showed 81 MB (66 single, 6 double and 1 triple) with variable length (<1 cm in the 58%, 1–2 cm in the 33%, and >2 cm in the 9%). We observed more superficial MB ($n = 60$, 74%) as compared to deep MB ($n = 21$, 26%). MB were more frequently located in the mid-distal segment of the LAD ($n = 75$, 93%). According to AHA classification, MB showed the following anatomical distribution: mid LAD, 49.4%; distal LAD, 33.3%; mid-distal LAD, 8.7%; proximal-mid LAD, 1.2%; first diagonal branch, 1.2%; proximal circumflex, 2.5%; second marginal branch, 1.2%; intermediate branch, 2.5%. No significant differences were found in patients characteristics (patients with MB vs. patients without MB, $P > 0.05$) (Table 1). However, patients with MB frequently presented with atypical chest pain ($n = 41$, 56%), and had significantly different ECG-stress test findings ($P = 0.0002$). In particular, they presented with equivocal/aspecific signs of ischemia at the stress-ECG ($n = 38$, 52%) (Table 1).

The segment with MB was always free of atherosclerosis. Coronary segments proximal to the MB presented no atherosclerotic disease ($n = 37$, 45.7%), positive remodeling ($n = 23$, 28.4%), ≤50% stenoses ($n = 14$, 17.3%), >50% stenoses ($n = 7$, 8.6%) (Table 2). In proximal segments we detected 11 non calcified (25%), 10 calcified (22.7%), and 23 mixed (52.3%) atherosclerotic plaques. Distal segments presented a significantly different atherosclerosis pattern ($P < 0.0001$): absence of disease ($n = 73$, 90.1%), positive remodeling ($n = 5$, 6.2%), and ≤50% stenoses ($n = 3$, 3.7%) (Table 2). In distal segments we detected 4 non calcified and 4 mixed plaques. In MB subgroup analysis of patients characteristics, no significant differences were found between patients without concomitant close atherosclerosis and patients with concomitant close atherosclerosis apart from gender ($P < 0.0001$) and age ($P < 0.05$) (Table 3). In patients with MB, no significant differences were found between segmental proximal atherosclerosis and main proximal AHA segments apart from left main trunk (LM) ($P = 0.006$) (Table 4). Atherosclerotic pattern of proximal and mid LAD significantly differs ($P < 0.05$) between patients with MB (proximal LAD: 38.4% no CAD, 37% positive remodelling, 16.4% ≤ 50% CAD, 8.2% > 50% CAD; mid LAD: 48% no CAD, 28.8% positive remodelling, 16.4% ≤ 50%, 6.8% > 50% CAD) and patients without MB (proximal LAD: 51.9% no CAD, 17.7% positive remodelling, 26% ≤ 50% CAD, 4.4% > 50% CAD; mid LAD: 54.7% no CAD, 13.8% positive remodelling, 16% ≤ 50%, 15.5% > 50% CAD) (Table 4, 5).

Discussion

The pattern of muscle fibres partially or entirely overlying a segment of an epicardial coronary artery is defined as MB. MB are most commonly localized in the middle segment of the LAD [1]. Ferreira et al. distinguished superficial and intramyocardial bridges, with 75 and 25% of cases, respectively [24]. In superficial or incomplete bridges, a segment is not fully covered by myocardial fibres, but by a thin layer of connective tissue, nerves, and fatty tissue. There is a relevant discrepancy between the extremely low prevalence reported with CCA (<5%), versus the relatively high prevalence reported on autopsy (from 5 to 86%) [1]. Discrepancies at autopsy may be attributable to the care taken at preparation and selection of hearts. The low rate of angiographic findings may be attributable to superficial courses causing little compression [12]. In subjects with angiographically normal coronary arteries, the use of provocative tests may enhance systolic myocardial compression and display MB in <40% of cases [1]. Moreover, the presence of a proximal atherosclerotic stenotic lesion may hide the subsequent bridging.

MB is asymptomatic in the majority of cases [2]. However, patients may present with atypical or angina-like chest pain with no relevant association between symptoms severity and the length or depth of the tunnelled segment or the degree of systolic compression [24]. Stress tests may show non-specific signs of ischemia [1]. While asymptomatic short and superficial MB warrant no intervention, management options for symptomatic MB may be pharmacologic (β-blockers and calcium channel blockers) or interventional (stents, coronary artery bypass grafting, and

Table 2 Atherosclerotic pattern in segments close to MB

Atherosclerosis pattern	Proximal segments (%)	Distal segments (%)
No CAD	37 (45.7)	73 (90.1)
Positive remodeling	23 (28.4)	5 (6.2)
Stenosis ≤50%	14 (17.3)	3 (3.7)
Stenosis >50%	7 (8.6)	0 (0)

MB coronary artery myocardial bridging, *CAD* coronary artery disease

(Proximal vs. distal segments $P < 0.0001$)

Table 3 Patients characteristics of MB subgroup

	No atherosclerosis (%)	Concomitant atherosclerosis (%)
Patients	32 (43.8)	41 (56.2)
Male	12 (37.5)	34 (82.9)
Female	20 (62.5)	7 (17.1)
Age (mean ± SD)	54.8 ± 9.6	61 ± 10.6
Diabetes	6 (18.8)	10 (24.4)
Smokers	13 (40.6)	19 (46.3)
Dyslipidemia	19 (59.3)	26 (63.4)
Hypertension	23 (71.9)	35 (85.4)
Family history	16 (50)	24 (58.5)
Obesity	24 (65.6)	18 (43.9)
Atypical chest pain	18 (56.3)	23 (56)
Typical chest pain	4 (12.5)	4 (9.8)
High-risk individuals	6 (18.7)	10 (24.4)
Ascending aorta evaluation	4 (12.5)	4 (9.8)
Negative ECG-stress test	15 (46.9)	16 (39)
Equivocal ECG-stress test	16 (50)	22 (53.7)
Positive ECG-stress test	1 (3.1)	3 (7.3)

MB coronary artery myocardial bridging

No significant differences were found between patients without concomitant close atherosclerosis and patients with associated atherosclerosis apart from gender ($P < 0.0001$) and age ($P < 0.05$)

surgical myotomy) [25]. Ischemia could be attributed to a combination of the following factors: increased heart rate compromising the diastolic filling, exercise-induced spasm, and systolic kinking which may cause an endothelium damage with platelet activation and thrombus formation. Moreover, the segment proximal to the MB frequently shows atherosclerotic plaque formation, although the tunnelled segment is typically spared [3, 26]. Low shear stress in the proximal segments may induce the release of endothelial vasoactive agents and contribute to atherosclerotic plaque formation, whereas high shear stress may have a protective role within the tunnelled segment [3, 27]. In addition, an increase in local wall tension may induce endothelial injury and plaque fissuring with subsequent thrombus formation in the proximal segment [28].

Another potential reason for absence of atherosclerosis in MB could be the missing epicardial adipose tissue, which may promote the pathogenesis of coronary atherosclerosis, as a complex vasocrine and paracrine organ [29].

CCA has been denoted as the imaging standard for the diagnosis of MB by showing systolic compression of the tunnelled segment [1]. Novel invasive imaging techniques such as IVUS and ICD may be employed to display the morphological and functional features of MB [4, 5]. IVUS studies supported the absence of atherosclerosis within tunnelled segments, although at least 90% of patients showed plaque formation proximal to the bridge [4]. Recent studies have described the feasibility of non-invasive CT-CA in visualizing MB with a reported prevalence between 3.5 and 58% [8–18]. 64-slice CT-CA studies reported

Table 4 Atherosclerosis pattern of patients with MB and statistical difference with proximal segments to the MB

AHA segment	No CAD	Positive remodeling	Stenosis ≤50%	Stenosis >50%	*P*
1	41 (56.2%)	20 (27.4%)	6 (8.2%)	6 (8.2%)	0.3504
2	38 (52%)	20 (27.4%)	8 (11%)	7 (9.6%)	0.6939
3	45 (61.7%)	15 (20.5%)	7 (9.6%)	6 (8.2%)	0.215
4	51 (69.9%)	14 (19.2%)	5 (6.8%)	3 (4.1%)	0.0195
5*	49 (70%)	14 (20%)	7 (10%)	0 (0%)	0.006
6	28 (38.4%)	27 (37%)	12 (16.4%)	6 (8.2%)	0.7079
7	35 (48%)	21 (28.8%)	12 (16.4%)	5 (6.8%)	0.9743
8	56 (76.7%)	12 (16.4%)	4 (5.5%)	1 (1.4%)	0.0007
9	44 (60.3%)	15 (20.5%)	9 (12.3%)	5 (6.9%)	0.3476
10	59 (80.8%)	8 (11%)	2 (2.7%)	4 (5.5%)	<0.0001
11	43 (58.9%)	17 (23.3%)	8 (11%)	5 (6.8%)	0.4057
12	52 (71.2%)	10 (13.7%)	5 (6.9%)	6 (8.2%)	0.0088
13	52 (71.2%)	13 (17.8%)	4 (5.5%)	4 (5.5%)	0.0103
14	58 (79.5%)	6 (8.2%)	2 (2.7%)	7 (9.6%)	<0.0001
15	65 (89%)	4 (5.5%)	4 (5.5%)	0 (0%)	<0.0001
16**	15 (57.7%)	5 (19.2%)	4 (15.4%)	2 (7.7%)	0.7339

MB coronary artery myocardial bridging, *AHA* American Heart Association classification, *CAD* coronary artery disease

* 3 patients present a left coronary split origin

** 26 patients (35.6%) present an intermediate coronary branch

Table 5 Atherosclerotic pattern of patients without MB and statistical difference with AHA 16-segments of patients with MB

AHA segment	No CAD	Positive remodeling	Stenosis ≤50%	Stenosis >50%	*P*
1 ($n = 181$)	79 (43.7%)	61 (33.7%)	31 (17.1%)	10 (5.5%)	0.1212
2 ($n = 179$)	79 (44.1%)	61 (34.1%)	27 (15.1%)	12 (6.7%)	0.4523
3 ($n = 177$)	88 (49.7%)	51 (28.8%)	29 (16.4%)	9 (5.1%)	0.1564
4 ($n = 176$)	111 (63%)	36 (20.5%)	17 (9.7%)	12 (6.8%)	0.6823
5 ($n = 176$)	144 (81.8%)	11 (6.3%)	20 (11.4%)	1 (0.5%)	0.1755
6 ($n = 181$)	94 (51.9%)	32 (17.7%)	47 (26%)	8 (4.4%)	0.0033
7 ($n = 181$)	99 (54.7%)	25 (13.8%)	29 (16%)	28 (15.5%)	0.0199
8 ($n = 178$)	146 (82%)	11 (6.2%)	14 (7.9%)	7 (3.9%)	0.055
9 ($n = 179$)	137 (76.6%)	19 (10.6%)	14 (7.8%)	9 (5%)	0.0667
10 ($n = 176$)	141 (80.2%)	19 (10.8%)	8 (4.5%)	8 (4.5%)	0.0457
11 ($n = 181$)	124 (68.5%)	17 (9.4%)	21 (11.6%)	19 (10.5%)	0.0296
12 ($n = 180$)	127 (70.6%)	22 (12.2%)	18 (10%)	13 (7.2%)	0.0537
13 ($n = 181$)	134 (74%)	20 (11%)	18 (10%)	9 (5%)	0.375
14 ($n = 178$)	139 (78%)	12 (6.8%)	12 (6.8%)	15 (8.4%)	0.6281
15 ($n = 179$)	159 (88.9%)	9 (5%)	9 (5%)	2 (1.1%)	0.8351
16 ($n = 57$, 31.5%)	42 (73.7%)	6 (10.5%)	6 (10.5%)	3 (5.3%)	0.53

MB coronary artery myocardial bridging, *AHA* American Heart Association classification, *CAD* coronary artery disease

a higher prevalence more comparable with autopsy rates than with angiographic series [11–18]. Kim et al. recently shown that the frequency of MB observed by CT-CA (58%) is higher than that of CCA (13.3%) [12]. Zeina et al. pointed out that bridging may predispose to the development of atherosclerosis

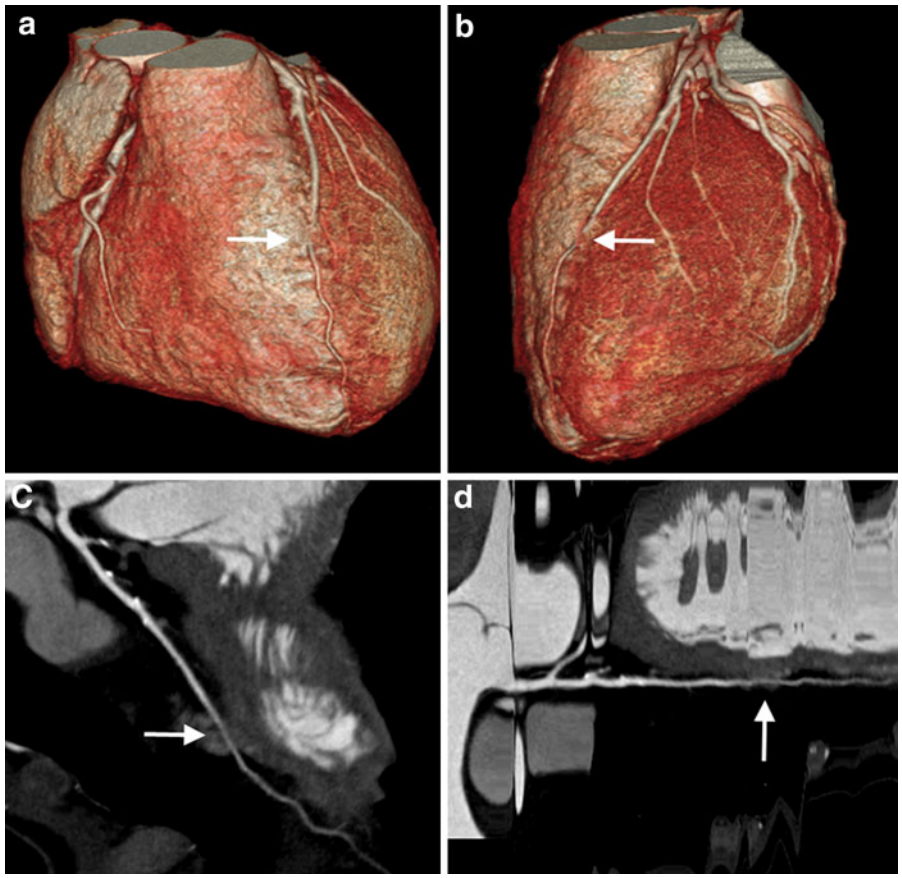

Fig. 1 58-year-old man with atypical chest pain. Superficial short MB (*arrow*) of the distal LAD with proximal not-significant calcified atherosclerotic lesions. VR (**a**,**b**), MPR (**c**), and stretch-vessel MPR images (**d**)

in the proximal segments [13]. Recent studies demonstrated also that the bridged segments appear to be free of atherosclerosis [14, 15]. Cademartiri et al. found that the prevalence of MB is higher in the patients with atherosclerosis (7.4% vs. 2.8%) [16]. Our previous pilot-study provided first observations to assess the association between MB and proximal atherosclerosis, with the relevant bias of inclusion of patients with known CAD and prior myocardial revascularizations [19]. The present study was designed to include only patients with suspected CAD and to assess the MB influence on coronary atherosclerosis distribution and pattern providing a comparison with a clinically similar group of patients without MB by means of CT-CA.

Our data suggest that CT-CA is an easy and reliable tool for a comprehensive in vivo diagnosis and characterization of the MB. The incidence is in concordance with the reported incidence of autopsy series and higher than reported in angiographic series, where the low rate of findings is attributable to superficial courses causing little compression [12]. Data regarding location, number (single or multiple bridged segments within the same vessel), length, depth (superficial MB may be easily displayed by means of post-processing), and associated close atherosclerotic lesions may be obtained. MB are often located in the mid-distal LAD (Fig. 1, 2) and predispose to atherosclerotic plaque formation in the proximal segments, as pointed out by the different atherosclerotic pattern compared to patients without MB. However, no differences were found in atherosclerotic pattern between proximal segments to MB and proximal right coronary/circumflex segments. On the other side, differences with LM and more distal segments may be primarily explained by the lower prevalence of atherosclerosis in the LM and in the more distal segments [30].

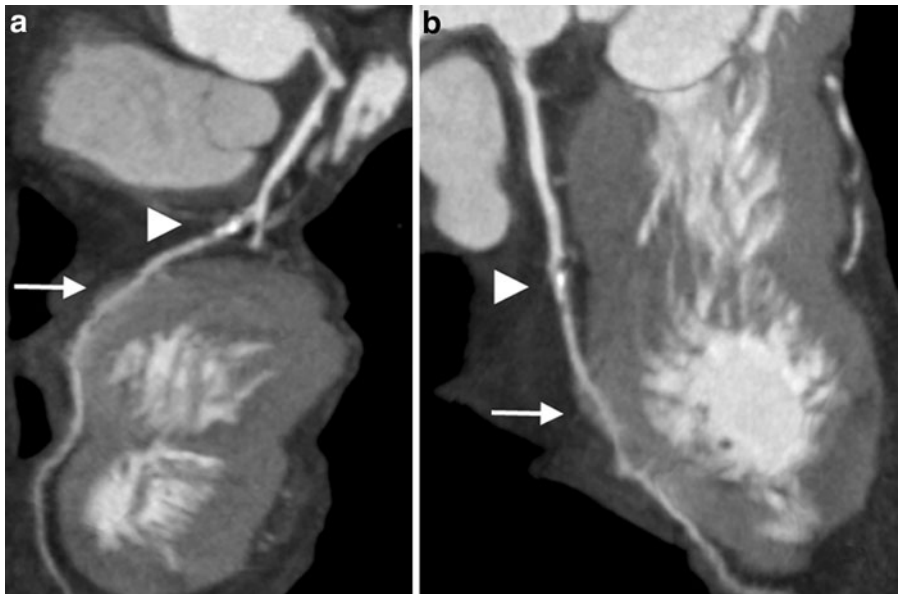

Fig. 2 64-year-old man with atypical chest pain and inconclusive stress test. Extended MB of the mid-distal LAD (*arrow*) with associated proximal mixed plaque and significant stenosis (*arrowhead*) displayed by MPR images (**a**,**b**)

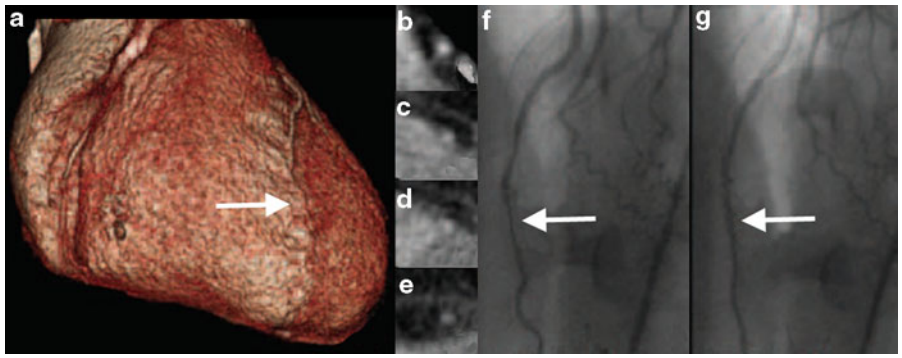

Fig. 3 59-year-old woman with atypical chest pain and inconclusive stress test. Symptomatic MB (*arrow*) of the mid-distal LAD depicted by VR image (**a**). Cross-sectional images show normal proximal vessel (**b**), tunnelled segment (**c**, **d**), and normal distal vessel (**e**). Conventional coronary angiography of the MB in end-systolic and end-diastolic phases (**f**, **g**)

However, our study has several limitations. The retrospective nature of the study cannot demonstrate the precise clinical relevance of MB in a population biased by the CAD presence. However, all patients underwent CT-CA according to existing clinical indications [6, 7] and both patients group (MB/no MB) had homogenous characteristics (i.e. age, gender, and risk factors). According to literature, MB frequently presents with atypical chest pain and aspecific ischemia-signs at ECG-stress test [18]. A descriptive study was carried out because comparison of findings with CCA was not always available. Only 15 patients with MB underwent CCA due to interventional purposes. In just one case the MB was elicited with CCA and considered responsible of the clinical presentation of the patient (Fig. 3). Finally, systolic compression was not evaluated by CT-CA because excessive motion artefacts during systolic phases precluded accurate lumen measurements. CT scanners with improved temporal resolution may allow to assess intermittent lumen narrowing with comparison of systolic and diastolic images [17, 31].

Finally, IVUS comparison for coronary plaque burden assessment was not available in our population.

In conclusion, 64-slice CT-CA may non-invasively provide comprehensive information regarding MB and associated proximal atherosclerosis. MB should be reported by operators because they may affect atherosclerosis distribution in the left coronary artery.

Conflict of interest None.

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