## Original paper Prevalence & characteristics of Myocardial Bridging in Patients Subjected to Computed Tomography Coronary Angiography in Iraq.

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### Abstract

ackground: Myocardial bridge occurs when one of the coronary arteries tunnels through the myocardium rather than its normal course at the epicardial fat, so it will be compressed during systole. Myocardial bridging was first recognized at autopsy more than 200 years ago, firstly reported in depth in 1951, and was recognized angiographically in 1960. Computed Tomography Coronary Angiography "CTCA" has been accepted as a reliable noninvasive imaging modality for the diagnosis of MB Aim of the study: studying the prevalence & characteristic of myocardial bridge among patients Subjected to Computed Tomography Coronary Angiography "CTCA" in Iraq Subject & methods: The study was conducted on 154 patients examined by CTCA, 110 (72%) was male & 44(28%) was female, between January 2013 till December 2014. distribution of MB patients among age, sex, were identified, types of MB, Bridging characteristics Coarse of the bridging within the muscle . Length of the segment of the bridging, Site of the bridging at the main coronary arteries LAD, LCX, RCA, The location of myocardial bridges in the LAD was classified according to segmental involvement as proximal, middle and distal, Associated atherosclerotic among MB patients was estimated. **Result:** This study show that myocardial bridging is common congenital anomalies with total prevalence "41.55%", more commonly seen in male "70% of patient with MB" than female "30% of patient with MB, with age distribution of 52+-11.4 y, the most frequently involved artery is the LAD (59 patient :92%) & the most frequently involved segment is the mid segment of the LAD "84.37%", with variable length of the involved segment "(42 +/-17.8) mm ,the superficial type is more frequent (56.25%) than the deep (43.75%) & there is increase occurrence of atherosclerosis at the pre bridging segment (94.7%) & less at the post bridging segment (5.26%), while is not observed at the bridging segment itself.

**Conclusion:** MB is common in Iraqi population; CTCA is useful for detection & characterization of MB & associated atheroscerltic changes

Keywords: MB, CTCA, LAD, Associated atherosclerotic.

### Introduction

The myocardial bridge (MB), first observed by Reyman in 1737<sup>(1)</sup>. It is defined as an anatomical variation, in which a segment of the coronary artery, which is normally courses epicardially, modifies its course, becoming intramural <sup>(2, 3)</sup>. The real prevalence of the MB is still unknown. Studies of autopsy have found that anatomical variation in 15 to 85% of the cases; however, it is still sub-diagnosed in vivo, having a prevalence which ranges between 0.5 to 4.5% in the conventional coronary angiography<sup>(4)</sup>.

Myocardial bridging, is a congenital anomaly, usually located over the mid portion of left anterior descending coronary artery (LAD) <sup>(5, 6)</sup>, it can cause systolic compression of tunneled segments. Clinically most patients with myocardial bridges are asymptomatic. but

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angina, acute myocardial infarction. ventricular fibrillation, myocardial ischemia, cardiac arrhythmias and sudden death are reported in some cases  $(^{7})$ . Isolated myocardial bridges of LAD have been reported in postmortem studies of young individuals, who died suddenly during strenuous exercises <sup>(8)</sup>. Myocardial bridge may initiate the development of atherosclerotic lesion or may facilitate progression by increasing shear stress on the proximal segment. The incidence of acute coronary syndrome rises in the when atherosclerosis patients is superimposed on MB<sup>(9)</sup>. CTCA has been accepted as a reliable noninvasive imaging 3D modality for the diagnosis of MB, because MDCT can provide information about the lumen and wall of the coronary arteries and the myocardium in any plane. MB can be depicted on CTCA even when there is no significant 'milking effect' as well as no change in vessel course (<sup>10, 11</sup>). while angiographic study only demonstrates the milking effect at the MB segment during systole. In Iraq there are angiographic nor anatomical neither information about the prevalence of MB, The purpose of this study is to assess the prevalence of MB of major coronary arteries in patients subject to Computed tomography coronary angiography (CTCA) in Iraq, and evaluate the morphological characteristics of MB, as well as study the relation between myocardial bridges (MB) and atherosclerosis in the left anterior descending coronary artery (LAD).

# Methods

Between January 2013 till December 2014, 154 patient, 110 (72%) was male & 44(28%) was female who underwent 64slice coronary CTCA in our institution were retrospectively reviewed to identify myocardial bridging. Patients were referred for coronary CTCA because of known or suspected coronary artery disease (CAD). The institutional review board approved the study; Written informed consent was not required because of the retrospective nature of the study.

All CT examinations were performed by a 64-slice CT scanner (light speed VCT 64, Systems, France) with GE Medical retrospective ECG gating (scan protocol is given in Table 1). Patients with a heart rate greater than 75 beats/min were pre medicated with an oral dose of 40 mg propronalol for three days before the scan. Sublingual nitroglycerine was delivered to the patient just before the scan. For venous access. an upper extremity vein (antecubital vein of the right arm) and a 20-gauge IV cannula was used. A total of 85-100 mL of contrast media with high iodine concentration ( $\geq$ 350 mg/mL) was injected with a flow rate of 5 mL/s, followed by a 20 mL saline wash out. The scan timing was determined with smart prep technique by placing the region of interest over the proximal ascending aorta and start exam after getting the best contrast concentration on monitor phase images.

Raw spiral CT data were reconstructed in various phases of the cardiac cycle to obtain images with the highest quality (without motion artifact). Reconstruction performed at 75% of R-R interval was found to be optimal for image analysis in most patients & 40%, 80% of the R-R interval in some patients.

## Image analysis

Images reconstructed at the optimal phase were transferred to another workstation (advantage work station 4.4 by GE) where image analysis was performed. All images were reviewed first in axial projection, then with post processing tools such as multiplanar reconstructions (MPR), curved planar reformat (CPR), thin-slab maximum intensity projection (thin MIP), and volume-rendering technique (VRT) with transparent background display. All CT examinations were reviewed by one radiologists experienced in cardiovascular Radiology & cardiovascular's physician. Demographic and clinical characteristics of MB including type of MB, bridging characteristic Coarse of the bridging within the muscle: Length of the segment of the bridging, Site of the bridging at the main arteries LAD LCX RCA, The location of myocardial bridges in the LAD was classified according to distribution as proximal, middle and distal. Distribution of MB patients among age, sex, was identified.

The tunneled segments of the LAD were divided as being superficial or deep depending on the depth of the tunneled segment ( $\leq 1$  or > 1 mm) (10). We also subdivided superficial MB into complete and incomplete based on the full or partial encasement of the LAD within the left ventricular myocardium (12). Because systolic compression can occur in coronary segments without overlying muscle (13) subdivision of superficial MB into complete and incomplete types is acceptable in our study.

#### **Statistical Analyses**

Data analyses and graphs were done using Graph pad PRISIM version six software (California\USA).

### Results

Distribution of myocardial bridge among patients Age and sex. Total No. of patients was 154, the incidence of MB among male was higher (70.31%) than female (29.68%) and this result is discrepancy significant (P < 0.05). Mean of age of total patients was (55.1+\- 3) while among patients with MB was (52+\-11.4) (Table-2, Fig. 1 A and B).

 Table 1. Scan protocol of 64-slice coronary CT angiography Scan protocol (GE light

spe	eed	VCT	64)	

TUBE CURRENT	automatically modified
Tube voltage	120 Kv
Tube rotation time	350 ms
Section thickness	0.6
Increment	0.22
Field of view	10.8 cm
ECG gating	Retrospective

Kv: Kilo voltage. ECG: Electrocardiograph; ms: millisecond

Table 2. Age, Se	ex and Number	of patients	with MB
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Age of patients	Total No. Of Patients (154)	Patients with MB (64)
Mean of Age (years+\-SD)	55.1+\- 3	52+\-11.4
Male	110(72%)****	45(70%)****
Female	44(28%)	19 (30%)

MB=Myocardial Bridge, SD= Standard Deviation, \*= Significant differences, Binomial test, P value < 0.0001



Fig 1. distribution of myocardial bridging among Age (A), sex (B) and Number of patients with MB.

#### Myocardial Bridging Characteristics

Results show that the prevalence of MB patients that having one segment of the artery are: 52, those with two segments =10 & three segment =2

Involvement of more than one artery = 2. Length of the segment of the bridging was  $(42 +/-17.8 \text{mm}^2)$ . While the Coarse of the bridging within the muscle was Within the LV & interventricual septum: 58 patients, Within the anterior part of the RT. Ventricle: 6 patients (Fig.2, A, B and C, Fig.3).

#### Location of the bridging

Most patients showed Myocardial bridging at mid segment of LAD 54 patient out of 64 (84.37%), but two had it at middle third of RCA also and 4 patients at middle third of LCX. Two cases (3%) at proximal segment of the LAD, and also recorded in distal segment of the LAD (3 patients, 4.68%) and in the distal segment of RCA (one patients out of 64, 1.5%), no cases were recorded in the proximal segment of LCX and RCA as well as in the distal segment of LCX. (Table-3, Fig.4, Fig5).



**Fig 2.** Myocardial Bridging characteristics: course of the bridging within the muscle (A); Bridging ccc (B) and length of the segment of the bridging (C).



Fig.3. A. volume rendering image B. volume rendering transparent muscles image shows the myocardial bridging, C, D, E & F Images shows course of the bridging within the muscle:
C&D: bridging coursed within the ant. RT. Ventricular wall with very thin layer of muscle separate it from RT. Ventricular cavity, E&F bridging coarse within the inter ventricular septum with thick layer of muscle separate it from RT. & LT. ventricular cavities.

Results shows two types of MB, deep bridging (Depth more than 1mm) and superficial bridging (depth of the tunneled segment equal or less than 1mm), the incidence of Superficial bridging (56.25%) was higher than deep bridging (43.75%). Among patients with superficial bridging there were 17 cases out of 64 cases (26.56%)had Complete Superficial bridging while19 patients out of 64 cases (29.68%) had Incomplete Superficial bridging (Fig.6, Fig 7). Atherosclerosis associated with myocardial bridging

Result shows that atherosclerosis is in 19 patients out of 64 (29.68%) MB patients. We found that atherosclerotic lesions were located proximally to the MB in18 patients out of19 (94.7%) of the patients with atherosclerosis and concomitant atherosclerotic stenosis in the LAD while one case showed atherosclerotic lesions at distal to the bridging (5.26%), there is no case with atherosclerosis within the bridging segment (Table-4, Fig.8 A , B &C).



E. Curved reformate images F. As

F. Axial view

Fig. 4. location of the myocardial bridging: A&B: LAD bridging, C&D LCX bridging, E&F RCA bridging

Table 3. location OF THE BRIDGING

Total	SITE OF THE	Location of the bridging		
no. of MB	SEGMENT	LAD No. (%)	LCX (%)	RCA (%)
64/154	Proximal segment	2 patient /64 3%	?? ??	
	Mid segment	54 patient /64 84.37%	4 patient /64 (6.25%)	2pat. /64 (3%)
	Distal segment	3 patients /64	??	1 pat.
		4.68%		(1.5%)
	Total			
		59 patients (92%)	??	

LAD= left anterior descending coronary artery, LCX= Left circumflex coronary artery, RCA= Right coronary artery.



Fig, 5 Location of the bridging



Fig. 6 distribution of different types of MB

## Discussion

This study showed that the depiction rate of MB was 64 out of 154 (44%) of total heterogeneous patient population. MB in other study in China was approximately 13.6% (14). and between the percentage recorded in the reports of several pathologic series (15–85%), there is wide variation of the prevalence of MB on conventional angiography as it required experienced eyes & only the deep type of MB that show significant systolic milking effect to be indirectly seen (15- 17). While CTCA showed the precise location of MB directly

Result shows that the age of patient with MB was 52+-11.4, the high range of SD reflect the age variation among MB

patients which recorded among patient with in 30 decades and seventy decades. This result was also recorded by other researchers who found that (81.82%) of MB cases were between twenty and sixty years and remaining (18.18%) between sixty and eighty years (18). Myocardial bridge probability should be considered in voung individuals presenting with angina and its equivalent or if the same symptoms are persistent in the patients without any risk factor for coronary artery disease or with only one risk factor. Positive exercise testing is rare in patients with MB (19, 20). Most of MB patients were male (70%) while 30% of cases were recorded among female patients; this result is similar to the findings in other studies (19-21).



Fig 7. Types of bridging according to the thickness of the overlying muscles: A&B deep LAD bridging; C&D Complete Superficial bridging; E&F Incomplete Superficial bridging

Table 4. Associated Atherosclerotic		
MB type	No. of patients (%)	
Proximal to the bridging	18 (94.7%)	
At the bridging	0	
Distal to the bridging	1 (5.26%)	
Total	19 (29.68%)	



Fig. 8 Atherosclerosis associated with myocardial bridging types.
A- Percent of position of the atherosclerotic plaques
B- Curved reformate image of the LAD with pre bridging atherosclerotic plaques
C- Curved reformate image of the LAD with post bridging non calcified plaque

Myocardial bridging is generally confined to the mid left anterior descending artery" LAD "(22). In our study the 54 patient out of 64 (84.37%) patients had myocardial bridges in mid LAD, 3 patients (4.68%) at the distal segment of the LAD while 2 patients (3%) at the proximal segment of the LAD. In addition, 4 patients out of 64 (6.25%) at mid segment of left circumflex "LCX ", while 2patients out of 64 (3%) at the mid segment of "right coronary artery "RCA" and only one patient (1.5%) at the distal segment of the RCA. Results show that the incidence of MB patients that Involve of one segment of the artery: 52, Involvement of two segments =10, segments =2, Involvement of three Involvement of more than one artery = 2. Length of the segment of the bridging was  $(42 \pm 17.8 \text{ mm})$ . Other study shows that the average length of MB in all segments of the coronary arteries was  $17.6 \pm 5.7$  mm (ranged from 8 to 40 mm). A longer MB

associated with more significant hemodynamic effects, and severe clinical symptoms, Feldman (23). The length of a coronary obstruction and maintaining constant the resting and reactive hyperemic flow, the pressure gradient between aorta and the distal coronary artery to be increased; therefore, a smaller dynamic stenosis can be associated with increased hemodynamic effects during at rest and reactive hyperemia if the length of the steno tic segment is increased. Other authors however couldn't find а correlation between MB length and the severity of cardiac symptoms (24).

MB can be classified as superficial or deep, depending on the thickness of the covering muscular layer ( $\leq 1 \text{ mm or} > 1 \text{ mm}$ ), even though there are no clear-cut in-depth criteria for the classification of MB depicted on CT (25). In addition, superficial MB can be classified as complete or incomplete in accordance with

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the extent of the vessel encasement by the myocardium. Because systolic compression can occur in coronary segments without overlying muscle (26) subdivision of superficial MB into complete and incomplete types is acceptable in our study. The prevalence of superficial MB (66%) was higher than that of deep MB (34%). Furthermore, about two-thirds of cases of superficial MB were considered to be incomplete MB.

The majority of MB cases belong to the superficial type which generally do not cause marked stenosis of the MB segment of the coronary artery in systole, but the deep type may stress and twist vessels, which not only causes arterial lumen stenosis in systole, but also influences the blood perfusion in the early and medium diastole to cause a clear decrease of coronary flow reserve. In addition, the arterial lumen readily undergoes spasm and secondary atherosclerosis and develops plaque rapture, hemorrhage and thrombosis, thus causing myocardial ischemia and even acute coronary syndrome (ACS).

Comparisons among various groups indicate that extent of arterial lumen compression correlates with MB thickness of the overlying muscles but not with MB length (27-29) therefore the classification of MB into deep & superficial & subdivision of superficial into complete & incomplete is important as it correlate with severity of clinical symptoms.

This study has shown that MB associated with increase the occurrence of atherosclerosis especially in the pre bridging segment. Myocardial bridge has been shown to lead to ischemic heart disease by several mechanisms. In our study atherosclerosis was recognized in 94.73% in segment of the artery prior to MB segment. The explanation for these findings, the underlying mechanisms is that MB increases the tendency for occurrence of atherosclerosis. Myocardial bridge causes atherosclerosis proximal to the bridge with its shear stress effect (3031). while atherosclerosis is not recognized within the segment of MB in our study which well explained in other study as the endothelium within the MB more has а structure resistant to atherosclerosis (31). We found that atherosclerotic lesions were located proximally to the MB in all of the patients with MB and concomitant atherosclerotic stenosis in the LAD. Ge et al (32) showed plaque formation proximal to the bridge in 90% of patients by intracoronary ultrasound. Ishikawa et al (33)demonstrated that atherosclerosis ratio in the proximal segments of LAD (up to 2.5 from the ostium) away cm was significantly lower in cases with MB located within 5 cm from the left coronary ostium than in the corresponding segments of control group in an autopsy study. On the other hand, our study showed that atherosclerosis ratio in the proximal LAD segments up to 2.5 cm away from the ostium in distal MB location group (over 5.0 cm from the left coronary ostium) was not different from that of control group. But, in our study we did not evaluate atherosclerosis according to MB location from the left coronary ostium. Myocardial bridge probability should be considered in young individuals presenting with angina and its equivalent or if symptoms are persistent in the patients without any risk factor for coronary artery disease or with only one risk factor. Myocardial bridge mav initiate the development of atherosclerotic lesion or may facilitate progression by increasing shear stress on the proximal segment (34).

## Conclusion

MB is common in Iraqi population; CTCA is useful for detection & characterization of MB & associated atheroscerltic changes

## Acknowledgment

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