

MORPHO-HISTOLOGICAL STUDY OF MYOCARDIAL BRIDGES OF CADAVERIC HEARTS

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ABSTRACT: INTRODUCTION: A band overlying the intramural segment of coronary artery-a place where the artery goes through myocardium instead of epicardium is called myocardial bridging (MB). A wide variation of 0.5%-90.4% occurs in the incidence of MB by the cadaveric and angiographic study. More over the occurrence of atherosclerosis in coronary artery segments under myocardial bridges still remains controversial. And so, the incidence of myocardial bridges and their association to atherosclerosis formation in cadaveric hearts was done morphologically and histological in this study. **METHODS:** 30 cadaveric hearts from department of Anatomy were examined. After cleaning the fat from epicardium, course of all three coronary arteries were delineated and observed for presence of MB. In the hearts that exhibited MB, the location, length of MB, its distance from the coronary ostium was measured. Sections were made proximal to MB, under MB and distal to MB in the vessels. The perimeter of the vessels were measured. The section was processed for histological study of intimal-media thickness ratio. **RESULT:** 24 hearts showed MB in the left anterior interventricular artery. One showed MB in right coronary artery. Multiple MB in single artery was seen rarely. The length of the MB segment was around 4 cm on an average. Mostly the MB is seen in the mid to distal part of the artery. The intima was found to be thinned out in the section of the vessel underneath the MB. **CONCLUSION:** This study concludes that Left coronary artery is the commonest to have myocardial bridges. But the occurrence of this MB in the distal part of the vessel in contrast to previous studies is an important finding to be noted. The presence of intimal thinning underlying the myocardial bridges questions the previous studies that claimed MB's protection of vessels from atherosclerosis.

KEYWORDS: Myocardial bridges, atherosclerosis, intimal media thickness, left coronary artery, heart.

INTRODUCTION: The coronary arteries often run through the epicardial adipose tissue in its course and presents with a band of myocardial tissue overlying that segment. This myocardial band is named as myocardial bridge(MB).^{1,2} It is reported to exist exclusively in left anterior descending artery (LAD) in its mid portion by few studies.^{3,4} MB was considered as a benign anatomical variant rather than a congenital anomaly.^{4,5,6} This was challenged by many studies that found close association between the presence of MB and cardiovascular disease(CHD), arrhythmias and sudden cardiac death.^{2,3,4,7,8,9,10,11,12} The reported incidence of MB ranges from 0.5-90. 4% that includes cadaveric, angiographic and multi-detector CT studies.¹³

Morphologically MB can be categorized into four types by combining descriptions of various studies as follows: ^{14 to 22}

1. Superficial- MB Fibers crossing the LAD artery transversely towards the apex of the heart and at an acute angle, the artery being in the groove.
2. Deep- MB fibers arising from the right ventricular trabeculae, cross the LAD transversely, obliquely or helically to terminate in the interventricular septum.
3. Subendocardial - MB fibers traversing into the right ventricle and right atrium.
4. Incomplete- MB fibers partly cover the tunneled artery along with fatty, fibrous or nervous tissue forming the rest of the cover.

The length of MB presents with many studies which contradict each other in their observations. A Study had reported that the length of MB ranges from 10-30mm.²² While another study claimed that a smaller dynamic stenosis can be associated with increased hemodynamic effects during rest and reactive hyperemia if the length of the stenotic segment is increased.²³ However, another study couldn't find correlation between length of MB and the severity of cardiac symptoms.²⁴ Few studies had found typically longer bridges, thicker and situated more closer to the origin.^{15,25}

The development of CHD in hearts with MB was described due to direct compression of coronary artery resulting in contraction in young adult and enhancement of previous underlying atherosclerotic disease especially in segment proximal to MB in older individuals.²² But many studies challenged this explanation. A study reported that mural portions of that vessel are rarely affected by atherosclerosis, unlike epicardial segments, in which atherosclerotic plaques are commonly found.² Another study stated that the atherosclerotic process occurs in mural segments in the same way and with the same frequency as observed in the extra mural segments of the artery.²⁶ While another stated that coronary artery segments lying under myocardial bridges have a higher tendency to build atherosclerotic plaques than epicardial segments do.¹⁴ Angiographic studies have shown segments underlying MB with Atherosclerotic coronary stenosis.^{27, 28,29}

Reports on the microscopic study of the coronary artery proximal, deep and distal to MB also exhibited opposing views. According to a report, tunica intima of coronary artery underlying MB was thinner while proximal part showed hyperplasia with atherosclerotic plaques.^{22,30} Whereas another report claimed that the proximal segment was the usual site for atherosclerotic plaques while the bridged segment was free due to the protective role of myocardial bridges.^{31,32,33}

These contradicting reports of previous studies and paucity of data in the Indian context necessitated this study of morpho histology of MB in cadaveric hearts.

MATERIAL AND METHODS: Formalin fixed 30 adult cadaveric hearts were obtained from department of Anatomy for this study. Individual hearts were examined for the presence of myocardial bridges along the course of coronary arteries. In hearts with MB, the location, direction of muscle fibres, length and breadth (in mm) of the MB and its distance from coronary ostium were measured.

Cross sections of 1cm thickness were taken from coronary arteries, proximal to MB, under MB, and distal to MB. The tissue was processed for histological study and the sections cut were subjected to Haemotoxylin and Eosin staining along with Sudan III stain. The sections were examined under microscope to note the ratio of intimal-media thickness and for the presence of atherosclerosis.

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OBSERVATIONS: Out of the 30 hearts examined for the presence of MB, 53.3% (16 hearts) exhibited MB. Among these, in 93.75% cases MB were seen along the course of (left coronary artery) anterior interventricular artery (AIVA) and in 6.25% cases along right coronary artery. Mostly the MB's were observed in the distal part of Left coronary artery. Except one heart all had left coronary dominance.

86.7% cases (13 hearts) exhibited single MB over the AIVA (Figure 1) and multiple MBs were seen in 13.3% cases (2 hearts) (Figure 2). The right coronary showed only single MB in all the cases (Figure 3).

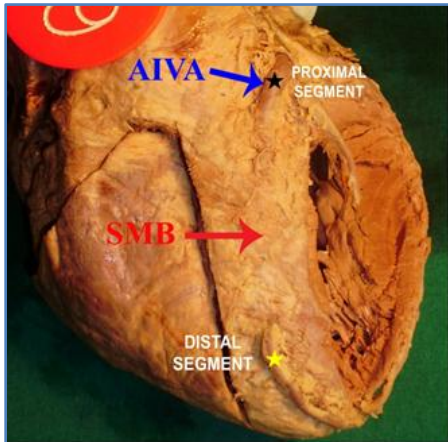


Figure : 1 - Showing single large myocardial bridge (SMB) on anterior interventricular artery (AIVA)

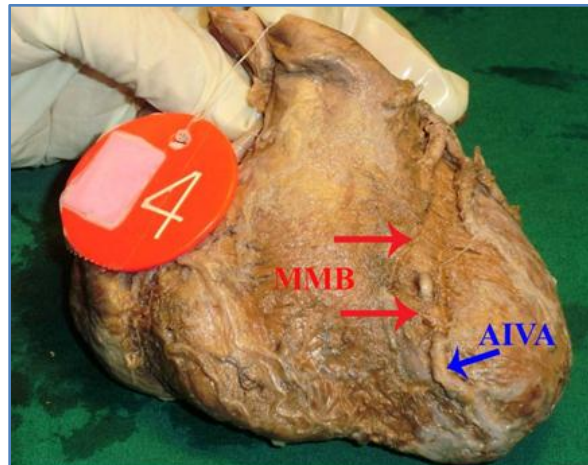


Figure : 2 - Showing multiple myocardial bridges (MMB) on anterior interventricular artery (AIVA)

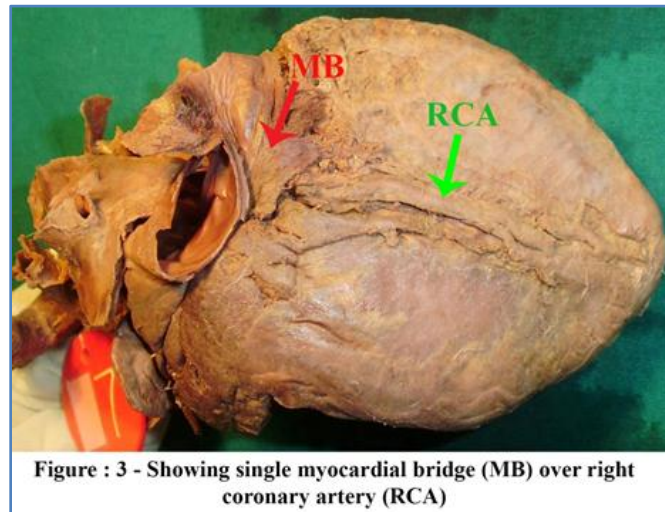
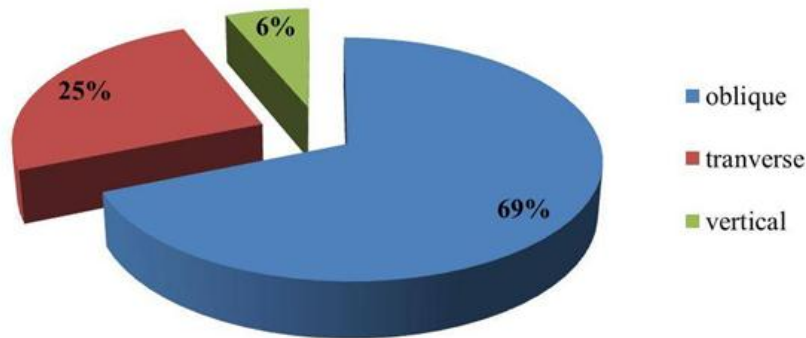


Figure : 3 - Showing single myocardial bridge (MB) over right coronary artery (RCA)

Three types of direction of MB fibers were noted. They were obliquely oriented muscle fibers, transverse and vertical (Graph: 1). All the MBs were of superficial type.

Graph 1: Showing direction of cardiac muscle fibres in myocardial bridge



The distance of MB from coronary ostium ranged from 53mm to 64mm with a mean of 58.75mm. The length of MB varied from 6 to 39 mm with a mean of 23.13 mm and breadth ranged from 7 to 27 mm with a mean of 12.75 mm.

The gross appearance showed thickened proximal segment of AIVA (Figure: 4). Histological section of the proximal segment showed increased intimal-media thickness ratio (thick tunica intima and media) and with an atherosclerotic plaque in the arterial wall (Figure: 5). The plaque was confirmed by Sudan III staining (Figure: 6).

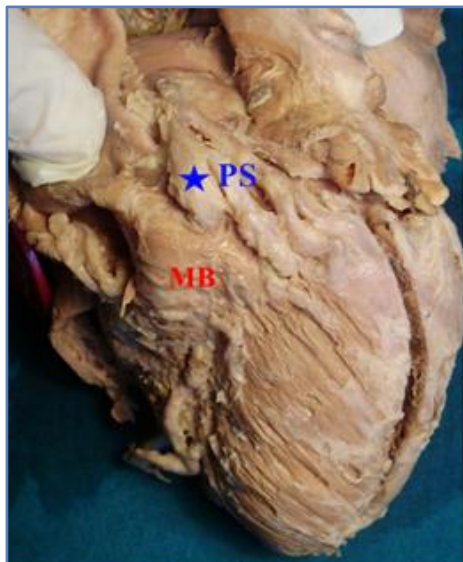


Figure : 4 - Proximal segment(PS) showing thickened atherosclerotic artery

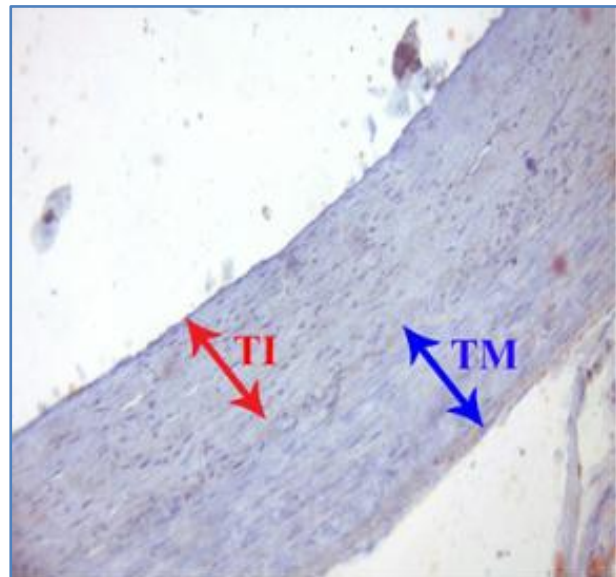
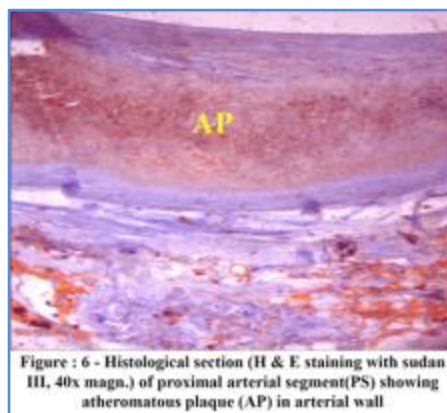
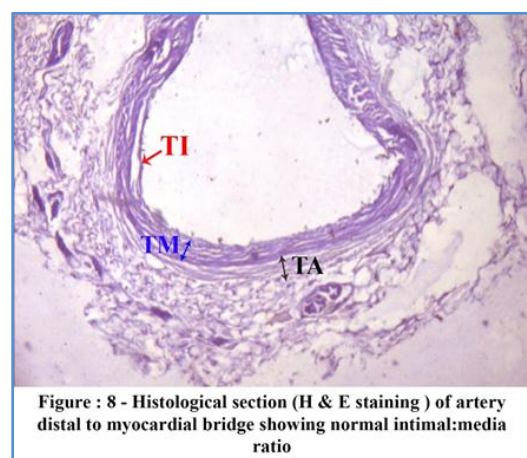
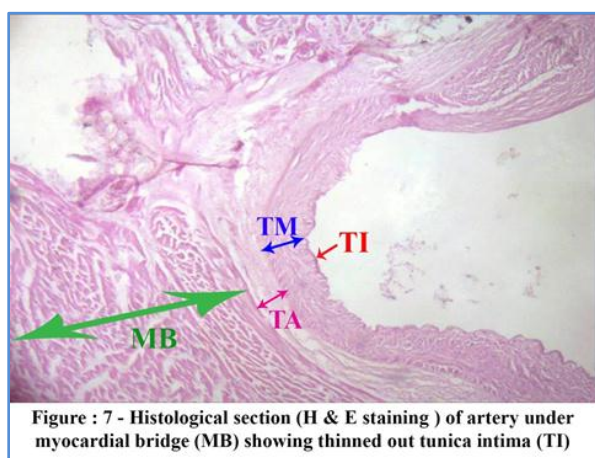


Figure : 5 - Histological section (H & E staining) of proximal arterial segment(PS) showing thick tunica intima and media



The sections under MB showed thinned out tunica intima and altered intimal-media thickness ratio. The lumen /diameter of the artery was narrowed below the MB compared to proximal or distal segment (Figure: 7). The distal segment sections were having normal intimal-media thickness ratio (Figure: 8).



DISCUSSION: Large number of observation of MB in angiography and CT with development of numerous theories explaining the effect of it on the arterial segment which directly affects the cardiovascular status of the individual necessitates more studies about MB. The present study observed morphological and also histological alterations occurring due to MB in an arterial segment of coronary arteries. With various studies quoting differing incidences of occurrence of MB,¹³ the present study's incidence of 53.3% is high for a cadaveric study done so far. The length of the MB observed by this study is low compared to another study which found 31mm as average length.³⁴ Multiple myocardial bridges occurring in a single heart have been observed in a number of studies with incidence ranging from 2-4%.^{33,34} This study also found almost similar incidence of multiple MB's.

The results of the current study show that myocardial bridges occur most frequently over the anterior interventricular branch of the left coronary artery, in agreement with the results of the majority of earlier studies.^{32,34,35,36,37} While less frequent instances of MB is in circumflex artery and occasionally in right coronary artery had been reported.²⁹

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It is important to note that the specimens examined had left coronary arterial dominance except one. This is rather unusual; it is generally considered that only one-tenth of the population has left coronary arterial dominance. Clinically, this may suggest that bridges could be less frequent in populations with the more usual spread of arterial dominance.

The demonstration of atherosclerotic plaques in the proximal segment histologically in the present study confers with reports that hypothesized that low wall shear stress promotes the formation of atherosclerotic plaque while high wall shear stress in segment underlying MB acts in a protective manner.³⁸ The altered intimal media ratio viewed in the histological sections parallels the observations of few previous studies.^{22,30,31,32,33}

The question “whether MB’s are clinically symptomatic or not?” needs further studies in large population with and without cardiac symptomatology.

CONCLUSION: This study concludes that left coronary artery is the commonest to have myocardial bridges. The occurrence of MB in the distal part of the vessels in contrast to previous studies is an important finding to be noted. The presence of intimal thinning underlying the MB questions the previous studies which proclaimed MB’s protection of vessels from atherosclerosis. It is evident from the present study that certain anatomic properties of the MB enhance the development of atherosclerosis in the arterial segment proximal to the MB, resulting in CHD.

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