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Original Article

PERCENTAGE INCIDENCE, MORPHOLOGY AND MORPHOMETRY OF MYOCARDIAL BRIDGES: A CADAVERIC STUDY

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ABSTRACT

Introduction: Myocardial bridging is the term used when a segment of major epicardial coronary artery runs intramuscularly under the tunnel formed by fibers of myocardium that bridges instead of it's normal or routine epicardial path. In the literature there are varying reports on clinical implications of myocardial bridges from protection against atherosclerosis to myocardial ischemia, as well as leading to infarction and sudden cardiac death.

Materials and Methods: 150 adult formalin fixed human hearts which were available in the department of Anatomy and Forensic Medicine, S.V.Medical College, Tirupati, Andhra Pradesh, India. These hearts were dissected and observed for the presence, location, type, number and direction of myocardial bridges and their association with coronary dominance. With the help of digital calipers morphometric parameters (length, width& thickness) of myocardial bridges and length of blood vessel underneath the myocardial bridge were measured, noted and photographs were taken.

Results: The overall incidence of myocardial bridges was 20.6%(31/150). Among these 18.6% (28/31) were on left anterior descending (LAD) artery and 2% (03/31) were on posterior interventricular (PIV) artery. The direction of muscle fibers in the bridges were oblique to the direction of the coronary vessels in majority of cases. Length, width and thickness of myocardial bridges were in the range of 12-69.7mm, 3.74-8.6mm and 1.3-3.87mm respectively.

Conclusions: Myocardial bridges may be associated with wide range of clinical problems. Contraction of myocardial bridge may results in vascular compression and myocardial ischemia. Knowledge on morphology and morphometric details of myocardial bridges facilitates cardiologists in diagnosis, planning therapeutic strategies and prognostic predictions.

KEY WORDS: Coronary dominance, left anterior descending (LAD) artery, posterior interventricular artery (PIV), myocardial bridge (MB).

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INTRODUCTION

Myocardial bridge is a band of myocardium over an intramuscularly running segment of coronary artery. It is not an uncommon finding during pathological examination of heart and coronary angiography. Myocardial bridges are considered

as an anatomical variation in coronary circulation and are supposed to be of benign nature. But, it evoked more controversies and has become a topic for discussion. These bands are observed from the time of birth and their development is closely associated with the growth of adjacent vessel [1]. A review of literature suggests dual role of myocardial bridge as both 'contributory risk factor' [2,3] and 'protective effect' for adverse cardiovascular consequences [4,5].

Normally the coronary vessels are epicardial in location. But in some cases the coronary vessel passes through a muscular tunnel for a short course and may reappear after its tunneling. The artery is called "tunneled artery" and the cardiac muscle over the tunnel is called "myocardial bridge". Myocardial bridges may be of two types i.e superficial or asymptomatic and deep or symptomatic depending on their arrangement [6].

Rayman [7] was the first to identify myocardial bridging .Portman and Ingrid [8] were the first to identify myocardial bridging (MB) radiologically. In depth analysis by autopsy was first done by Geiringer (9). A review of literature on myocardial bridges presented a wide variation both in its percentage of incidence and in distribution of the vessel.

Reported prevalence of myocardial bridges is 5.5% to 90%(10-16) in anatomical studies. This wide range in prevalence rate is because of varying sample size, population and dissection method adopted. The incidence of MB reported in angiographic studies are very less than that reported by anatomical studies and were in the range of 0.8%-12% (17-19). This wide difference may be because of different techniques and criterion used in diagnosis while some small sizes of MB which may not be clearly seen may be missed while observing radiological images.

The clinical symptoms of MB may depend on its location, length and thickness. If these bridges are of significant size they may cause pressure over the coronary artery leading to coronary insufficiency. The aim of present study is to find out the incidence, morphology and morphometry of MB and its relation to coronary dominance in human cadavers by dissection method in the population of Andhra Pradesh region of South India.

MATERIALS AND METHODS

This work was carried out on 150 adult human heart specimens of both sexes received from the department of Anatomy and Forensic Medicine, S.V.Medical College, Tirupati, Andhra Pradesh region of South India following the protocol approved by the institutional ethical committee. The specimens were preserved in 10% formalin for 2-3 days after recording their weight. After careful dissection of epicardial fat along the course of coronary arteries type of coronary dominance, number of myocardial bridges, their location in relation to the branches of coronary artery and their direction were recorded. The length, width and thickness of myocardial bridges and the length of coronary vessel underneath the bridge were measured with the help of digital calipers (Mitutoyo digital calipers, model no. CD- 6'' CSX) and the specimens were photographed.

Statistical analysis: The recorded data were statistically analyzed using SPSS 20 software. Karl Pearson coefficient of correlation was applied to find out Correlation between:

- Length of coronary vessel and weight of heart.
- Length of vessel and length of myocardial bridge.
- Weight of heart and length, width and thickness of myocardial bridge.

P value < 0.01 was considered as significant.

RESULTS

Among 150 heart specimens 31 hearts (20.6%; Table 1) presented a total of 35 myocardial bridges (23.3%). Among 31 hearts with myocardial bridges 27(87.1%) presented with right coronary dominance, two hearts presented left dominance (6.45%) and two hearts exhibited balanced dominance (6.45%) (Table 1).

Table 1: Percentage Incidence of Myocardial bridges in heart specimens and coronary dominance.

Dominance	Total	Incidence (%)
Right	27	87.1
Left	2	6.45
Balanced	2	6.45

Fig. 1: Showing myocardial bridging on LAD. MB: Myocardial bridge, LAD: Left anterior descending artery.

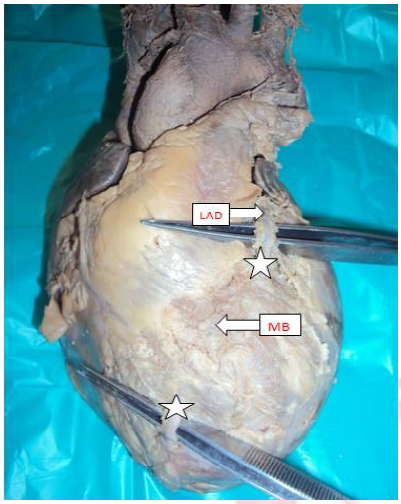

Fig. 2: Showing two myocardial bridges (MB) on left anterior descending artery (LAD).

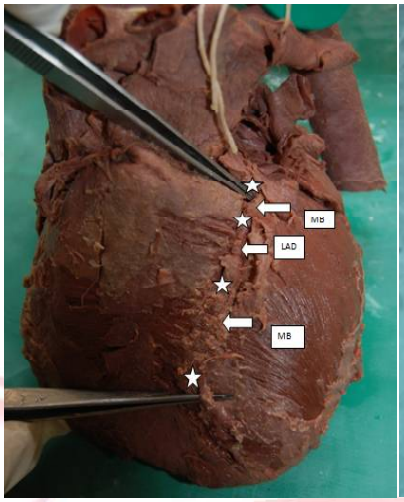

Fig. 3: Showing myocardial bridging on LAD. MB: Myocardial bridge, LAD: Left anterior descending artery.

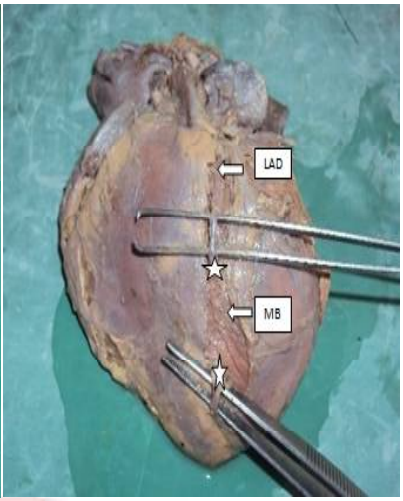

Fig. 4: Showing myocardial bridge (MB) on posterior interventricular artery(PIV).

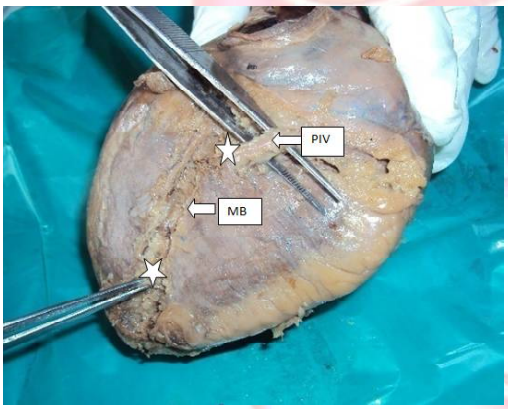

Table 2: Incidence of single and double MBs on LAD & PIV arteries.

Name of vessel	Single MB	Double MB	Total
LAD	26	2	28
LAD+PIV	-	2	2
PIV	1	-	1
TOTAL	27	4	31

Table 3: Mean and standard deviations of length, width & thickness of MB according to coronary dominance.

Dominance	Weight of hearts (gms)	Length of vessel under MB (cms)	Length of MB (mm)	Width of MB (mm)	Thickness of MB (mm)
Right	305 ± 92.79	12.50 ± 1.58	12.50 ± 1.58	6.26 ± 1.21	2.03 ± 0.67
Left	325 ± 35.36	13.75 ± 1.06	13.75 ± 1.06	7.30 ± 1.84	2.30 ± 0.28
Balanced	370 ± 42.43	13.0 ± 1.41	13.0 ± 1.41	5.95 ± 0.64	2.35 ±0.49

Parameters		wt in gms	length of vessel	length	width	thickness
wt in gms	Pearson Correlation		.504(**)	-0.022	-.442(*)	0.118
	p-value		0.004	0.906	0.013	0.526
length of vessel	Pearson Correlation	.504(**)		-0.102	0.026	0.071
	p-value	0.004		0.585	0.889	0.706
length	Pearson Correlation	-0.022	-0.102		0.149	0.161
	p-value	0.906	0.585		0.422	0.388
width	Pearson Correlation	-.442(*)	0.026	0.149		0.263
	p-value	0.013	0.889	0.422		0.153
thickness	Pearson Correlation	0.118	0.071	0.161	0.263	
	p-value	0.526	0.706	0.388	0.153	

Table 4: Karl Pearson coefficient of correlation between weight of heart and length of vessel.

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Among the 31 hearts with MB, single bridge was observed in 27 hearts (87.1%; fig.1) and two bridges (fig. 2) in 04 (12.9%) hearts. The single bridge was noted on LAD in 26 hearts (96.3 %) and on PIV artery in one (3.7%) heart. Double bridges on LAD alone in 2 specimens (fig:2) and one each on PIV and LAD in two hearts (Fig.3&4) were also observed. Among the 35 myocardial bridges 32 (91.4%) were observed on LAD and 03 (8.6%) on the PIV (Table 2).

When the location of myocardial bridges in relation to upper, middle and lower segments of coronary artery were analyzed, majority of bridges were distributed on middle segment of LAD(69.1%) with an incidence for upper(23%) and most minimum for lower (7.9%). The direction of myocardial bridge fibers on coronary vessel were transverse in 80%(28/35) and oblique in 20% (07/35) of MBs observed in the present study.

Mean and standard deviation of weight of heart, length of vessel under the MB, length, width and thickness of myocardial bridges with reference to coronary dominance is represented in Table 3. The weight of heart and thickness of myocardial bridge is significantly high in balanced circulation. The length of vessel under the myocardial bridge, length & width of myocardial bridge are high in left dominant hearts.

When Karl Pearson coefficient of correlation was calculated (Table 4) there is a significant correlation between length of vessel and weight of heart and weight of the heart and width of the myocardial bridge ($p<0.01$) at 1% level and 5% level respectively, and no significant ($p>0.01$) correlation between length of vessel and length of myocardial bridges.

DISCUSSION

Major course of coronary arteries is subepicardial and generally dip into the myocardium at their termination. Occasionally a segment of coronary artery or its branch runs an intramural course underneath bridge of myocardium. Morphology of myocardial bridge plays an important role in pathophysiology of different cardiac diseases. Wide variations in the percentage incidence of myocardial bridges were reported by different authors in literature based on anatomical dissection or angiographic method of study employed. Myocardial bridges can be easily identified during normal anatomical dissection but difficult to identify in the angiographic procedures, as display of myocardial bridge depends on its length, thickness, orientation of muscle fibers and also on blood pressure in the vessel [17].

Percentage incidences of MBs reported by dissection method of study on different ethnic population were compiled in Table 5. The range in percentage incidence of MBs reported in the literature based on observations in population of different regions is 5.5 % - 90.4% [10-16]. The wide variation in percentage incidence of MBs can be due to size of the sample, ethnic and regional factors or observer's interpretational difference like not considering the thin bridges or focusing only on a particular vessel.

Table 5: Percentage incidence of myocardial bridges reported in literature in adult hearts.

Author, Year, Race	Sample size (n)	% of hearts with MB	Total number of MB
Geringer E [9].,1951	100	23	-
A.G.Ferreira et al [6]., 1991, Brazil	90	55.6	70
Adam Kosinski et al [15]., 2000, Poland	100	41	50
MariosLoukas et al [11]., 2006, Poland	200	34.5	81
Bharambe&Arole [23], 2008,Maharashtra, North India	50	56	28
Luis Ernesto et al [13]., 2009, Colombia	154	40.3	92
H.Saidi et al [12]., 2010. Nairobi, Kenya	109	40.4	44
Bandhyopadhyay et al [14]., 2010, West Bengal, India	42	90.4	57
ChndrasekharKT&Harsha BR. [16] 2015, Mysore, Karnataka, India.	50	70	46
Almira Lujinovic et al [22]., 2013, Cekalusa	30	53.33	24
Rajendra Prasad etal [10], 2013 – Kerala, South India	400	5.5	22
Dipalarya et al [24]., 2013, Surat, North India.	,50	52	26
Swayamjothidorai raj. S. [25]2012-Chennai, Tamilnadu, India.	50	12	9
Swaroopet.al..[26]., 2014, South India	50	70	46
Srivastava Monika MS [27].2014, North India	60	36.7	25
Present study- Andhra Pradesh, South India	150	20.6	35

Table 6: Showing distribution of myocardial bridges on LAD&PIV.

Name of the author	% of incidence on LAD	% of incidence on PIV
MariousLoukas et al [11]	43.2	6
L E Ballesteros [13]	66.3	3.25
Adam Kosinski et al [15]..	33	4
Chandrasekhar KT &Harsha BR. [16]	43.49	13.04
AlmiralLujinovic [22]	62.5	4.17
Bharambe & Arole [23],	56	6
Dipalarya et al [24].,	46.15	23.07
Swayamjothidorai raj. S. [25]	12	6
Srivastava Monika MS [27].	36	5
Present study	91.4	8.6

Percentage incidence of hearts with MBs observed in the present study by anatomical dissection method is much lower than any of the reported incidence in literature except that of Rajendra Prasad et.al. [10] who reported a lowest incidence of 5.5% in 400 autopsies of North Kerala population of south India. According to them it is lower in North Keralites than Northwest Indians, Taiwanese, Japanese, Czechs and Brazilians. Bandhyopadhyay et.al. [14] reported highest incidence of 90.4% in West Bengal region of India.

A study on 50 foetal hearts of similar region as that of present study in the same area and the Institute by Kandregula et.al. [20] 18% incidence of MBs were reported. This clearly suggests that the percentage incidence of myocardial bridges was less in the region in which the present study was conducted, as our values on adult hearts were close to the values reported in fetuses by Kandregula et.al. [20]. A similar study by Yousuf Ozgurb Cakmak et.al [21] on 39 foetal hearts reported 46.2% in turkey population.

Percentage incidence of more than one bridge per specimen in the present study was 12.9% (4/35). Bandyopadhyay et.al., [14] reported 36%(14/38) incidence for more than one bridge in West Bengal population which is greater than that observed in the present study in South Andhra Pradesh population.

Location and morphometry (length and thickness) of myocardial bridge influence the degree of coronary obstruction. A review of literature (Table 6) suggests that the most com-mon bridged vessel is LAD. Next common vessels were diagonal branch of left coronary artery, left marginal, circumflex and posterior inter ventricular branches [11,13,14,15,22,23]. In our study a highest incidence of 91.4% of myocardial bridges were found on LAD which was not reported in literature. Next to this the common vessel with bridging was posterior interventricular artery (8.6%) which is also slightly higher than the incidence reported by several authors [11,13,15,22,25,26,27]. But Chandrasekhar & Harsha [16] and Dipal arya et. al. [24] reported higher incidence of myocardial bridges on PIV in population of Karnataka and Gujarat region of India respectively than in the present study in Andhra Pradesh region of south India.

In the literature (Table 7) the most common artery with maximum percentage of MBs was LAD with a higher incidence on its middle segment followed by proximal and distal segments [6,14,16,28]. The same pattern of incidence was observed in the present study. But the percentage incidence on middle segment of LAD was less than that reported by Vanildo et.al., [28] and Dipal arya et.al. [24] and more than that reported by Bharambe & Arole [23], and Bandyopadhyay et.al. [14]. The incidence on proximal segment is less than that reported by Bharambe and Arole and Vanildo et.al. [23, 28] and more than that reported by Bandyopadhyay et.al. (14) and Dipal arya et.al.[24]. The incidence on distal segment is similar to that reported in literature except that of Bandyopadhyay et.al. [14] who reported a higher value.

Table 7: Showing distribution of myocardial bridges on LAD.

Author's name	Proximal part of LAD	Middle part of LAD	Distal part of LAD
Bandyopadhyay et.al. [14]	40%	45%	15%
Bharambe& Arole [24] Maharashtra, India	20%	28%	8%
Dipal arya [25]	33.30%	58.33%	8.33%
ML.Vanildo et al (2002)[28]	13.33%	86.66%	-
PRESENT STUDY	23%	69.20%	7.80%

Different studies reported a wide range in the length of MBs. Geringer [9] reported the smallest length of 5mm. In our study we observed the minimum length of 12 mm. The maximum length

obtained in the present study (69.7mm) was greater than that reported in the literature (Table 8). The thickness of the bridge observed in the present study is similar to that reported in literature by Adam Kosinski [15] and Almiral Lujinovic [22] (Table 8).

Table 8: Morphometry of myocardial bridges reported by various authors.

Name of the author	Length range in mm	Thickness range in mm	Width range in mm
MariosLoukas [11]	31(mean)	12(mean)	-
L E Ballesteros [13]	19.9(average)	-	-
Adam Kosinski [15]	2.3 - 42.8	1.0 -3.8	
AlmiralLujinovic [22]	14.6±9.03	1.23± 1.32	-
Srivastava monika MS [27]	9 -61 IN LCA 14-17 IN RCA	-	-
PRESENT STUDY	12 – 69.7	1.3 – 3.87	3.74 – 8.6

The LAD is the most clinically important vessel affected by myocardial bridges. Along with other factors morphometry of myocardial bridge also plays an important role in a patient with unstable angina and in other cardiac conditions. The percentage incidence of MBs were less than that reported in literature. But, more lengthy bridges were seen in the present study than that reported .The lengthy bridges will be more effective than the thin and short bridges.

CONCLUSION

The results obtained in the present study on cadaveric hearts of Andhra Pradesh region of South India suggests that

1. Majority of myocardial bridges were located on middle segment of LAD (69.1-%).
2. Direction of muscle fibers in myocardial bridges are transverse in majority of cases (80%).
3. More lengthy bridge (69.7mm) than that reported in literature was observed.

Morphometry of myocardial bridges may help the cardiologist during their clinical practice and for proper planning of surgical procedures like surgical myotomy of myocardial bridges.

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Conflicts of Interests: None

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