The Study Of Myocardial Bridges

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Abstract : According to text (Gray's Anatomy[12] 39th Edition) the coronary arteries may dip into the myocardium for varying lengths and then reappear on the heart's surface. This muscle overlying the intramyocardial segment of the epicardial coronary artery is termed a myocardial bridge .The present study is aimed at studying the presence of myocardial bridges over coronary arteries and their branches by dissection method. A total of 50 adult hearts procured from dissection room cadavers from Department of Anatomy, Dr D Y Patil Medical College Pune, were included in this study irrespective of sex. The hearts were meticulously dissected along both the coronary arteries and the presence and location of myocardial bridges was noted along with the part of the artery and / or its branch it was crossing. The overall prevalence of myocardial bridging was found to be 56%. An attempt was made to co-relate the presence of myocardial bridges and dominance of coronary arteries. Maximum incidence of myocardial bridges was observed over the left coronary artery in case of right coronary dominance (40%).

Key words: Coronary arteries, myocardium, myocardial bridges, dominance

Introduction :

Myocardial Bridging was first described by Geiringer[1] in 1951.Since then many reports have appeared. Polacek[2] (1961) believed that Myocardial Bridges played a role in sclerotic process since intimal hyperplasia of the arteries was observed, proximal to the Bridges. Also the angiographic appearance at the site of Myocardial Bridges shows distortion resembling focal disease process and could result in a misinterpretation during study on coronary angiographs.

There is a wide variation in percentage of hearts showing Myocardial Bridging in every study reported. The present study has been undertaken for detailed anatomical study of Myocardial Bridges by dissection method.

Geiringer[1] in 1951 presented an in depth analysis of myocardial bridges studied by dissection method on autopsy samples and reported an incidence of 23% with predominance of myocardial bridges on anterior interventricular artery.

Polacek[2] in 1961 examined 70 hearts and reported an incidence of myocardial bridges of 85.7%.

A G Ferriera[3] et al in 1991 in a necropsy study of 90 hearts found myocardial bridging in 55.6%.The left anterior descending artery was reported to be the most commonly affected artery in this study.

Pracownia Badan[4] et al in 1998 reported a case of 69-year-old male suffering from episodes of unstable angina whose angiography showed a myocardial bridge over the left anterior descending coronary artery, causing systolic lumen reduction of 87%, but lack of atherosclerotic changes. Myocardial ischaemia produced by the myocardial bridges was confirmed by perfusion scintigraphy.

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Harikrishnan S[5] et al in 1999 in their study of cineangiograms of 3200 cases found myocardial bridges in 21 cases i.e an incidence of 0.6%.All cases had myocardial bridges in the proximal or middle segment of anterior interventricular artery and one case had whole of posterior interventricular artery under a myocardial bridge. Two patients had large saccular coronary aneurysms proximal to the muscle bridging.

Stefan Möhlenkamp[6] et al in 2002 claimed that on an average, myocardial bridges were present in about one third of adults. The rate of angiographic bridging was 5%, attributable to thin bridges causing little compression. In subjects with angiographically normal coronary arteries, the use of provocation tests may enhance systolic myocardial compression and thereby reveal myocardial bridges in 40% of cases. Myocardial bridges were seen to be most commonly localized in the middle segment of the left anterior descending coronary artery .He observed that angiographically, myocardial bridges were almost exclusively spotted on the anterior interventricular artery.

Vanildo[7] et al in 2002 in a study carried out with 30 postmortem hearts having myocardial bridges extending over the anterior interventricular artery, reported myocardial bridges over the proximal third of the anterior interventricular branch in 13.33% (4/30) of the hearts studied, and over the middle third of that branch in 86.66% (26/30) of the hearts studied. No myocardial bridge was observed over the distal third of the anterior interventricular branch.

M J Lovell[8] et al in 2003 stated that though Myocardial bridges cause clinically relevant problems only in certain patients, wide range of clinical problems, including acute coronary syndromes and arrhythmias, have been reported in patients whose sole apparent cardiac abnormality was the presence of a myocardial bridge. Thus some connection between myocardial bridges and acute coronary syndromes cannot be completely denied.

Harminder Singh[9] et al in 2005 reported a case of complete occlusion in the distal segment of left anterior descending artery by a myocardial bridge with complete obliteration of lumen during systole. He claimed that myocardial bridging of coronary arteries is a frequent congenital anomaly that is almost exclusively confined to the left anterior descending artery and that though myocardial bridge is usually benign, it can be associated with unstable angina, myocardial infarction, ventricular arrhythmias and sudden cardiac death.

Heribert Schunkert[10] in 2005 reported a case of stenosis of left anterior descending coronary artery in a patient complaining of retrosternal chest pain detected on Angiography. Extensive myocardial bridging was reported distal to the lesion. He postulated that the lesion could be a result of turbulent blood flow and increased wall stress at vessel sites proximal to myocardial bridging.

Shirani[11] in 2006 maintains that intramural course of coronary artery has been associated with myocardial ischemia though its exact mechanism has not been fully elucidated.

Aims and objectives :

A myocardial bridge crossing a coronary artery often shows transient distortion of lumen of the artery which can be interpreted as a coronary block on an angiogram. There have been variable reports regarding percentage of hearts showing myocardial bridges and their distribution over different branches of coronary arteries.

Materials and methods :

A total of 50 hearts were included in this study irrespective of sex. The hearts were procured from dissection room cadavers from Department of Anatomy, Dr D Y Patil Medical College Pune and were preserved in 10% formalin. All the cadavers were adults.

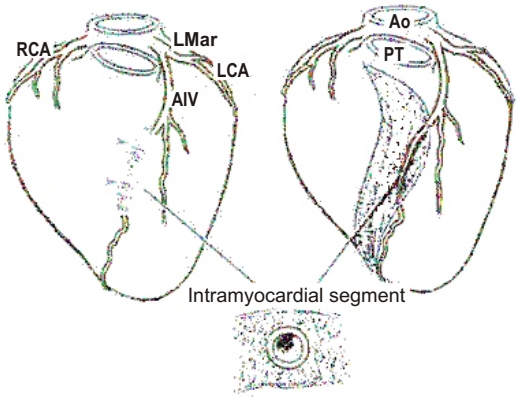
The right and left coronary arteries were traced by cleaning the epicardium and fat piecemeal using artery forceps, blunt forceps and mosquito forceps. The origins and course of the 2 coronary arteries were thus cleared.

The left coronary artery along with its branches was dissected as it passed between the auricle and pulmonary trunk. It was followed to its most distal end. The right coronary artery along with its branches was also dissected and followed to its most distal end. The presence and location of myocardial bridges was noted along with the part of the artery and / or its branch it was crossing.

Specimens showing Myocardial Bridges were photographed from various angles and the photographs were numbered.

Anatomy of Myocardial Bridges

According to text (Gray's Anatomy[12] 39th Edition) the coronary arteries are usually subepicardial but those in the atrioventricular and interventricular sulci are often deeply sited, occasionally hidden by overlapping myocardium. Thus they may dip into the myocardium for varying lengths and then reappear on the heart's surface. This muscle overlying the intramyocardial segment of the epicardial coronary artery is termed a myocardial bridge (MB) and the artery coursing within the myocardium is called a tunneled artery.



Left Diagram- showing hidden anterior interven-tricular artery (AIV) (arrowheads).
Right Diagram- Myocardium opened and artery seen passing through the myocardial tunnel. Below- Transverse section of Left ventricular wall showing tunneled coronary artery surrounded by myocardium.(Ao-Aorta, LCA-Left coronary artery, LMar-Left marginal artery, PT-Pulmonary trunk and RCA-Right coronary artery)

Observations :

In this study overall prevalence of myocardial bridging was found to be 56% seen by dissection method.

It was found to be more common over the left coronary artery and its branches (54%), than the right coronary artery and its branches (6%)(Table 1).

Table 1
Comparison of incidence of myocardial bridges over LCA and RCA

	LCA	RCA
Number of hearts showing myocardial bridging	27	3
Percentage of hearts showing myocardial bridging	54%	6%

Out of the 3 hearts showing myocardial bridges over the right coronary artery (Table 1), 2 hearts also showed myocardial bridges over their left coronary arteries.

In case of the left coronary artery, the incidence of myocardial bridging was more frequently seen over its anterior interventricular branch (46%) (fig 1 a,b)(Table 2 a,b) and here too it was found to be most frequent over the middle 1/3rd segment (28%) (Table 3).

Table 2(A)
Chart showing total incidence of myocardial bridging and its comparative incidence over individual arteries

Total number of hearts showing myocardial bridging-28

Percentage of hearts showing myocardial bridging-56%					
Myocardial bridges seen over	Left coronary artery			Right coronary artery	
	AIV	Left diagonal br	Left marginal br of crmx	1st segment	PIV br of RCA
Number of hearts showing myocardial bridging	23	8	4	2	3
Percentage of hearts showing myocardial bridging	46%	16%	8%	4%	6%

Myocardial bridges were also observed over the left diagonal artery and its branches (16%) (fig 2,3 a,b), left marginal branch of circumflex artery (8%), 1st segment of right coronary artery (4%)(fig 4 a,b) and posterior interventricular branch of right coronary artery(6%) (fig 5 a,b) (Table 2 a,b) .

Table 2(B)

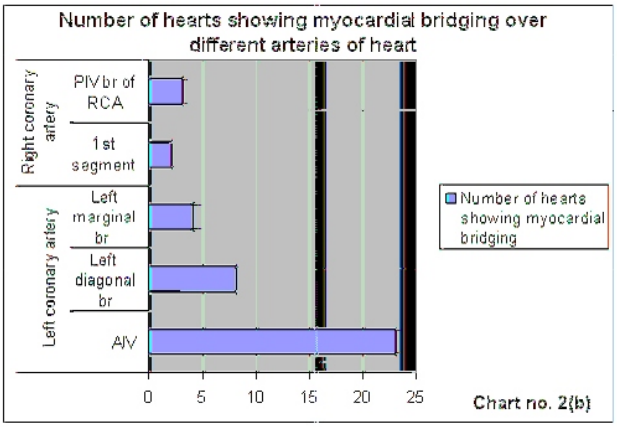


Table 3
Chart showing distribution of myocardial bridges over AIV artery

	AIV		
	proximal 1/3rd	middle 1/3rd	distal 1/3rd
Number of hearts showing myocardial bridging	10	18	4
Percentage of hearts showing myocardial bridging	20%	28%	8%

Fig. 1(a) : Myocardial bridges seen over proximal 1/3rd of anterior interventricular artery. (Heart no.9)

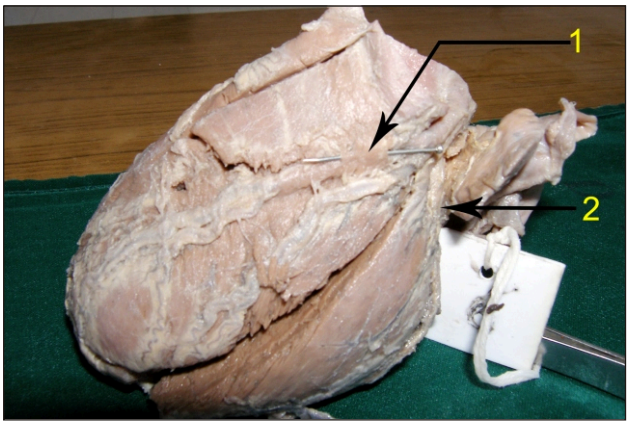


Fig. 1(b) :

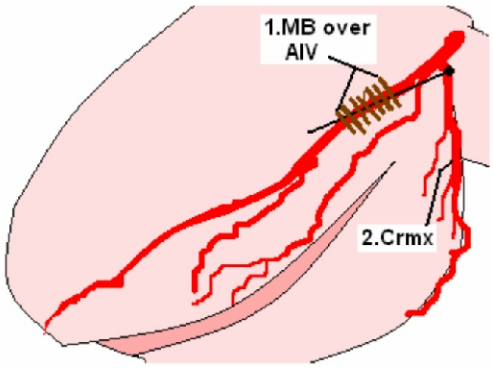


Fig. 2(a) : Myocardial bridges seen over left diagonal artery and its branches. (Heart no.15)

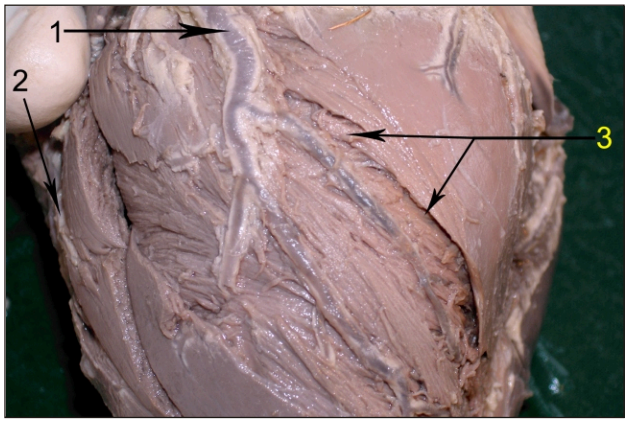


Fig. 2(b)

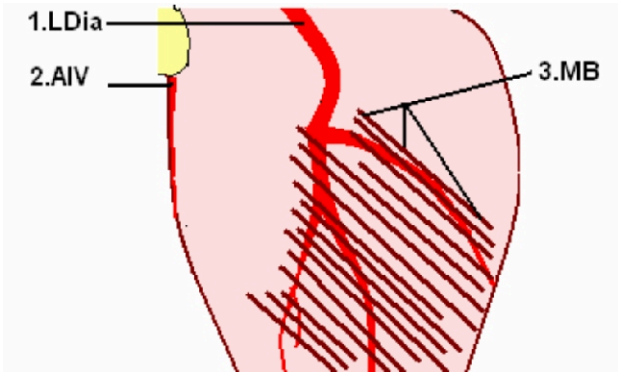


Fig. 3(a) : Myocardial bridges seen over left diagonal artery and its branches. (Heart no.1)

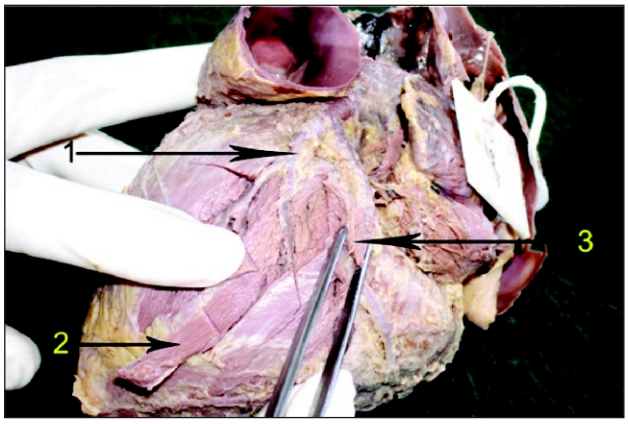


Fig. 3(b)

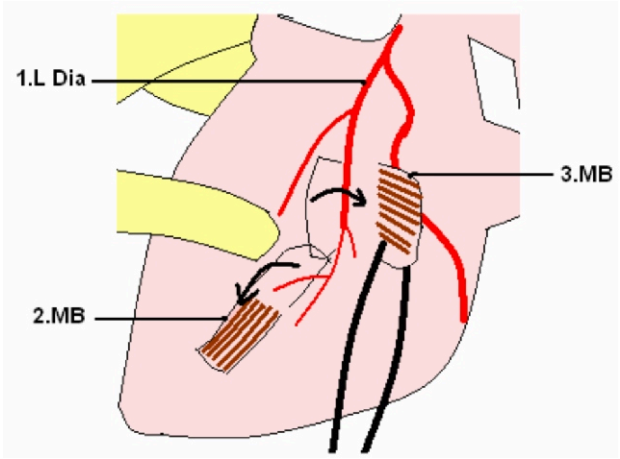


Fig. 4(a) : Myocardial bridges seen over 1st segment of right coronary artery. (Heart no.44)

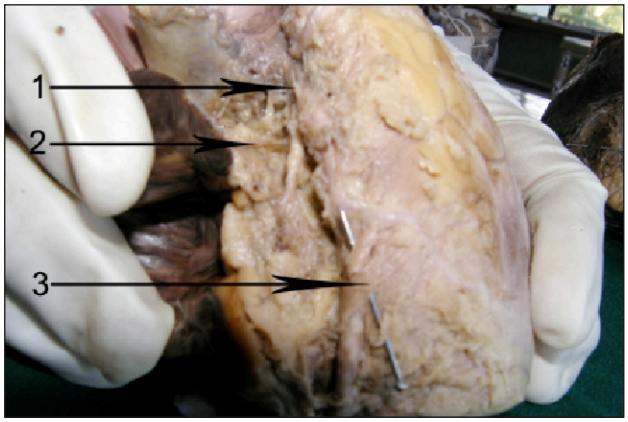


Fig. 4(b)

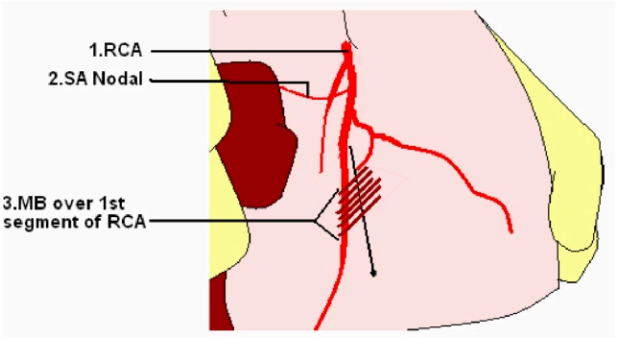


Fig. 5(a) : Myocardial bridges seen over posterior interventricular artery.(Heart no.44)

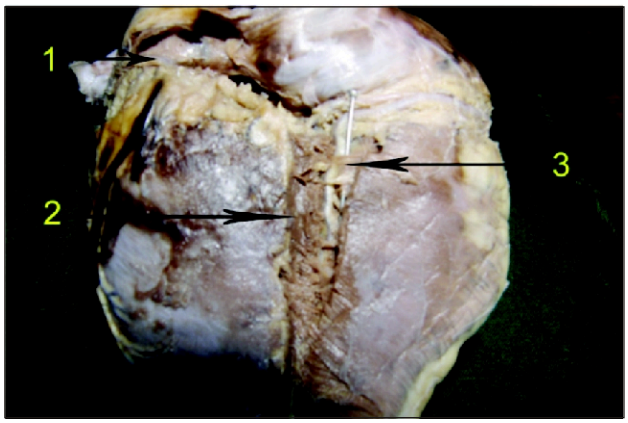
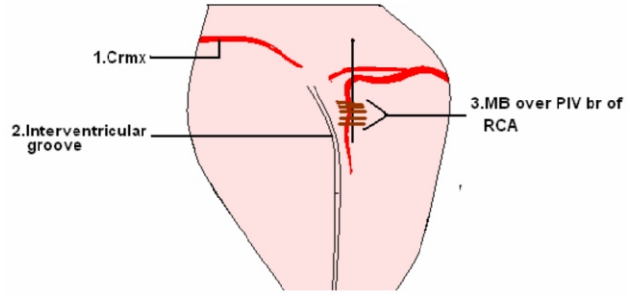


Fig. 5(b)



Discussion :

Muscle fibres of myocardium overlying coronary artery were first mentioned by Reyman[13] in 1737.

They were described as 'myocardial bridges' by Geiringer[1] in 1951.

Observations regarding myocardial bridges show variable findings depending upon method of study used. While **angiographically** myocardial bridges are seen exclusively over anterior interventricular artery, in the present study done by **dissection method** myocardial bridges have been demonstrated over both coronary arteries and their branches with a predominance over anterior interventricular artery.

Table 4 depicts the incidence of Myocardial bridges reported since the earliest studies on the same and is compared with present study (ref chart nos. 1, 2, 3).

The incidence of myocardial bridging in this study (Table 4) corresponds to the incidence reported by A G Ferriera[3] 1991 and Reig[14] 1993 though significantly greater than findings by Geiringer[1] 1951 , Pelech[15] 2006 and Loukas[16] 2006 using the dissection method of study.

High incidence of "myocardial bridges over anterior interventricular artery" reported in the present study correlates with the findings of Geiringer[1], Pelech[15] and Loukas[16] .

However 46% incidence of myocardial bridges over the anterior interventricular artery as reported in the present study (Table 2 a) is higher than the findings reported by the above authors.

In the study by Angelini[17] 1983 and Harikrishnan[5] 1999 using the method of Angiography all the bridges reported were on anterior interventricular artery but the incidence was lowest i.e 5.50% and 0.60% respectively.

In the present study highest incidence of bridges (28%) was observed over the middle 1/3rd of anterior interventricular artery. Vanildo[7] 2002 also reported a high incidence (88.66%) of bridging over the middle 1/3rd of anterior interventricular artery though the percentage of incidence reported is much higher than that reported in the present study.

The separate 8% incidence of myocardial bridges over the distal 1/3rd of the anterior interventricular artery has been reported for the 1st time in the present study.

The incidence of myocardial bridges seen over the proximal and/or distal 1/3rd of anterior interventricular, left diagonal, left marginal and posterior interventricular arteries is also higher in the present study than the findings reported by Loukas[16] 2006.

All the authors have reported myocardial bridges over anterior interventricular artery except Loukas[16] 2006 who found bridges over the same arteries as in the present study but there is no report of myocardial bridges over different segments of anterior interventricular artery which has been reported in the present study. However total percentage of myocardial bridges seen was greator in the present study 56% in comparison with 34.50% observed by Loukas[16].

Thus in the present study a higher percentage of incidence of myocardial bridges was observed over all the arteries except over 1st segment of right coronary artery. A 4% incidence of myocardial bridges was observed on the 1st segment of right coronary artery in the present study whereas a higher incidence of 7.50% was reported by Loukas[16] 2006.

Lovell[8] in 2003 stated that though Myocardial bridges may cause clinically relevant problems only in certain patients, wide range of clinical problems, including acute coronary syndromes and arrhythmias, have been reported in patients whose sole apparent cardiac abnormality is the presence of a myocardial bridge.

Table 4
Incidence of Myocardial Bridges

		LCA					RCA	
	Percentage of incidence of MB	proximal 1/3rd of AIV	middle 1/3rd of AIV	distal 1/3rd of AIV	diagonal br	marginal br of crmx	PIV br of RCA	Over 1st segment of RCA
Dissection method								
Present study (2007)	**56%**	**20%**	**28%**	**8%**	**16%**	**8%**	**6%**	**4%**
Geiringer[1] 1951	23%	Over AIV artery						
Ferreira[3] 1991	55.60%	Arteries not specified						
Reig[14] 1993	58%	All coronary arteries						
Vanildo[7] 2002		(Out of the total hearts showing MB)						
		13.33%	86.66%	nil				
Pelech[15] 2006	5%-25%	AIV						
Loukas[16] 2006	34.50%	17.50%			7%	2.50%	4%	7.50%
Angiographic method								
Angelini[17] 1983	5.50%	Over AIV artery						
Harikrishan[5] 1999	0.60%	All the MB observed were over the AIV						

Tunneled coronary arteries have long been recognized anatomically, but suggested associations between myocardial ischemia and myocardial bridges have heightened their clinical relevance.

The variable incidence of myocardial bridges can be explained to some extent by studying the development of coronary vessel systems described by Reese[18].He states that in the earliest stages of cardiogenesis the heart is tubular, made of an endothelial tube within a muscular tube. At this stage there is no epicardium.

The cells forming the epicardium arise from an outgrowth called Proepicardial organ from the septum transversum. These cells migrate to envelope the heart to form the epicardium and pericardium. Signalling mechanisms regulate the migration of the

epicardial cells which in turn give out the signals that participate in regulation of myocyte proliferation, growth and final pattern of myocardium.

The epicardial cells undergo epithelial-to-mesenchymal transition controlled by factors from the myocardium. The mesenchymal cells thus formed migrate through the spaces generated in the developing myocardium finally forming the coronary arterial system. This migration of these mesenchymal cells through the developing myocardium could explain the embryogenesis of myocardial bridges over portions of coronary arteries. This is an area needing further in depth study.

Co-relation between Myocardial Bridges and Dominant artery

According to Loukas[16], presence of myocardial bridges appeared to be related to coronary dominance. Hence the present study attempts to co-relate presence of myocardial bridges and dominance of coronary arteries.

According to text (Gray's Anatomy[12] 39th Edn) the term 'dominant' is used to refer to that coronary artery which gives origin to the "posterior interventricular artery".

In 'right dominance' the posterior interventricular artery arises from the right coronary artery.

In 'left dominance' the posterior interventricular artery arises from the left coronary artery.

In case of 'codominance' the posterior interventricular artery is seen originating from both right coronary artery and left coronary artery.

Using these criterion the incidence of dominance was studied in the hearts.

Following chart (Table no.5) depicts the incidence of myocardial bridging over the dominant and non-dominant arteries as observed in the present study in comparison to the incidence reported by Loukas[16].

Table 5
Incidence of MB seen over dominant and non-dominant arteries

		MB over LCA in case of RCAD	MB over RCA in case of RCAD	MB over LCA in case of LCAD	MB over RCA in case of LCAD	MB over LCA in case of codominance	MB over RCA in case of codominance
Present study (2007)	**No. of hearts**	**20**	**3**	**3**	**0**	**3**	**1**
	Percentage of hearts	**40%**	**6%**	**6%**	**0%**	**6%**	**2%**
Loukas 2006	No. of hearts	6	11	42	4	4	2
	Percentage of	3%	6%	21%	2%	2%	1%

It is observed that there is maximum incidence of myocardial bridges over the left coronary artery in case of right coronary dominance (40%). From this finding it can be inferred that in case of obstruction of the left coronary artery due to myocardial bridging, the wider distribution of right coronary artery in right coronary dominant heart may result in lesser part of myocardium suffering from an infarct. This incidence is much higher than the 3% incidence reported by Loukas[16].

In case of **codominance** effects of obstruction due to myocardial bridging would be less due to the interventricular septum being supplied by both right and left coronary arteries.

Incidence of myocardial bridges over right coronary artery in right coronary dominant heart and left coronary artery in left coronary dominant heart was found to be 6% each. In both these cases an obstruction of the dominant artery due to it being covered by a myocardial bridge would result in widespread effects due to larger percentage of myocardium being supplied by the dominant artery. Loukas[16] reports a 21% incidence of myocardial bridges over the left coronary artery dominance which is much higher than the incidence reported in the present study.

Summary :

The incidence of myocardial bridges over coronary arteries and their branches was studied by dissecting 50 cadaveric hearts.

- Overall prevalence of myocardial bridging was found to be 56%. It was found to be more common over the left coronary artery (54%) than the right coronary artery (6%). In case of the left coronary artery, the incidence of myocardial bridging was more frequently seen over its anterior interventricular branch (46%) and here too it was found to be most frequent over the middle 1/3rd segment (28%) which is the highest incidence reported.
- 8% incidence of myocardial bridges over the distal 1/3rd of anterior interventricular artery has been reported for the 1st time in the present study.
- Myocardial bridges were also observed over the left diagonal artery (16%), the left marginal artery (18%), 1st segment of right coronary artery (4%) and over the posterior interventricular branch of right coronary artery (6%).
- In the present study highest percentage of incidence of myocardial bridges was

observed over all the arteries except over 1st segment of right coronary artery. A 4% incidence of myocardial bridges was observed on the 1st segment of right coronary artery in the present study whereas a higher incidence of 7.5% was reported by Loukas[16] 2006.

- Maximum incidence of myocardial bridges was observed over the left coronary artery in case of right coronary dominance (40%). Thus in case of a left coronary block the wider distribution of right coronary artery may reduce the size of the infarct.
- A 6% incidence of myocardial bridges was observed over the dominant artery which is lower than the 21% incidence by Loukas[16].
- A co-relation between myocardial bridges and dominance of coronary artery has been attempted in the present study.

Thus myocardial bridges may be associated with a wide range of clinical problems, including acute coronary syndromes and arrhythmias. The contraction of the myocardial bridge may result in vessel compression and myocardial ischaemia. The final effect of such compression and size of the resultant infarct could depend upon the state of coronary artery dominance in that individual.

References :

1. Geiringer E.The mural coronary.Am Heart J 1951;41:359-368.(Quoted by Mohlenkamp et al in 2002)
2. Polacek P,Kralove H.Relation of myocardial bridges and loops on the coronary arteries to coronary occlusions.Am Heart J 1961;61:44-52. (quoted by Vanildo Junior de Melo Lima et al in 2002)
3. Ferreira AG Jr,Trotter SE,Konig B Jr,Decourt LV,Fox K and Olsen EG. Myocardial bridges: morphological and functional aspects.British Heart Journal 1991; 66:364
4. Pracownia Badan Serca i Naczyn, Oddzial Kardiochirurgii Szpitala im. J. Strusia w Poznaniu. Intracoronary stent implantation for treatment of myocardial ischemia induced by myocardial bridge. A case repor.Polish Heart Journal 1998 Jun;Vol XLVIII,Nr 6
5. Harikrishnan S.Sunder KR,ThakaranJ,Titus T,Bhat A,Sivasankaran S,et al.Clinical and angiographic profile and followup of myocardial bridges:a study of 21 cases.Indian Heart J.1999 Sep;51(5):503-7
6. Mohlenkamp,Waldemar Hort,Jumbo Ge, Raimund Erbel.Update on myocardial bridging.Circulation.2002;106(20):6-11
7. Vanildo Junior de Melo Lima,Jennecy Sales Cavalcanti,Tetsuo Tashiro.Myocardial bridges and their relationship to the anterior interventricular branch of the left coronary artery.Arq.Bras.Cardiol.2002 Sep;79(3):219-222
8. Lovell MJ and Knight CJ. Invasive assessment of myocardial bridges.Heart 2003;89:699-700.
9. Singh Harminder,Singh Charanjit ,Kumar A,Aggarwal N, A Banerji. Acute Myocardial Infarction Secondary to Myocardial Bridge Treated with Drug-Eluting Stent; Indian Heart J 2005; 57: 734737.
10. Heribert Schunkert. Focal Coronary Atherosclerosis Proximal to Myocardial Bridging.Circulation 2005;107:1944
11. Shirani Jamshid, Alessandra Brofferio.Isolated Coronary Artery Anomalies. [Online]. 2003[cited 2006 Jun 20];[11screens].Available from:URL: URL:http://www.topmedconsultants.com/ emedi ine/ evaluations /mainsurvey.cfm?ecik=0030445.
12. Henry Gray.Gray's Anatomy.38th ed. Edinberg: Churchill Livingstone 1999. p1505-10
13. Reyman H C.Disertatio de vasis cordis propriis.Med Diss Univ Gottingen 1737 Sep 7;1-32.(Quoted by Mohlenkamp et al in 2002).
14. Reig J, Petit M. Main Trunk of the Left Coronary Artery: Anatomic Study of the Parameters of Clinical Interest.Clinical Anatomy 2004;17:6-13
15. Pelech A N. Coronary artery anomalies.[Online]. 2004 Jun 12 [cited 2006 Aug 18];[10 screens]. Available from:URL:http://www.emedicine.com/ ped/topic2506.htm.
16. Loukas M,Curry B, Bower M,Louis RG, Bartozak A,Kiedrowski M,et al.The relationship of myocardial bridges to coronary artery dominance in adult human heart.Journal of Anatomy.2006 Jul;209:43
17. Angelini P,Trivellato m,Donis J and Leachman RD.Myocardial Bridges :a review.Prog Cardiovasc Dis 1983;36:75-88.(Quoted by J Reig Vilallonga in 2003).
18. Reese, Takashi Mikawa, David M. Bader. Development of the Coronary Vessel System. Circulation Research 2002;91:761