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MYOCARDIAL BRIDGES – A STUDY ON HUMAN CADAVERIC HEARTS

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ABSTRACT

Back ground of study: Coronary arteries affected by the intramural tunneling carry a major role in the incidence of coronary artery disease and subsequent risky surgical intervention.Understanding the prevalence of myocardial bridges is of enormous help to the cardiologists and cardiac surgeons to reduce the complications in various interventional procedures.

Materials & methods: A dissection study was carried out in fifty human hearts after removing the pericardium and subepicardial fat. Each coronary artery was traced from its origin to termination to detect the sites of myocardial bridges.

Results: Myocardial bridging was detected in 23 % specimens of male sex and 19 % specimens of female sex. Left anterior descending artery was the main vessel affected by this.

Summary–Though there is no gender based prevalence for the myocardial bridges, the middle segment of left anterior descending artery is the main site of coronary artery overbridging. A sound knowledge about this very important to prevent the risk of perforation during surgical correction of myocardial ischemia which are refractory to medical management.

KEYWORDS : Coronary artery disease, Myocardial bridge, Left anterior descending artery(LAD)

INTRODUCTION

Incidence of coronary artery disease is increasing with each decade of life and more and more patients are being admitted to coronary care units. The most important causative factor of myocardial ischemia is coronary artery disease (CAD) resulting from atherosclerotic narrowing of these vessels. What was not possible in India 20 years back is now readily available at common man's doorstep. In the past several studies were conducted to display the normal and variant anatomy of coronary arteries, but a few were done on the myocardial bridges. The coronary arteries which encircle the heart like an inverted crown have a subepicardial course. But these vessels may dip into the myocardium and reappear after a short distance. This dipping phenomenon which is known by the name " Myocardial bridge " has a major role in the present clinical scenario of coronary artery disease.This comprehensive study aims to detectthe prevalence of myocardial bridges in our population, as it is considered as one of the predisposing factors of myocardial ischaemia and risk factor for surgical intervention .

MATERIALS AND METHODS

After the receiving the clearance from Human Ethical Commit tee,this dissection study was conducted in the Department of Anatomy,GovtMedical College, Thiruvananthapuram, Kerala, India over a period of three years.Thestudy groupcontained total fifty specimens. Thirty four hearts belonged to male sex and sixteen belonged to female sex. A few hearts with severely damaged vessels and foetal hearts wereexcluded from the study group.

The right coronary and the left coronary arteries were traced from their origin to termination after removing the epicardium and subepicardial fat manually. The specimens were studied for the dipping of coronary arteries into myocardium and their reappe arance after some distance. Dipped vessels were photographed. The length of dipped area was measured using measuring scale and calipers .The total percentage of myocardial bridges was shown in Pie chart. The prevalenceof myocardial bridges in male and female groups studied separately and tabulated. The data obtained from the present study was compared with the previous data in the literature.

RESULTS AND ANALYSIS

Dissection is the technique that offers highest frequency of detectionof myocardial bridges than any other clinical investigative methodology. Myocardial bridges were observed in 22% of specimens studied(Figure 1). It was detected in 8 (24 %) specimens of malesex and 3 (19 %) specimens of female sex(Table 1). Table 2 shows the comparative figures in literature.

Left anterior descending artery (LAD) wasthe most affected vessel by myocardial bridging . The tunneled area was the middle segmentof LADin all the specimens (Figures 2).The length of the dipped area varied from 0.5 cm to 2cms. One specimen showed the dipping of LAD without its reappearance (Figure 3). Present study could not detect the involvement of other arteries by myocardial overbridging . This study shows that there is no gender based variation in the incidence of myocardial bridging.

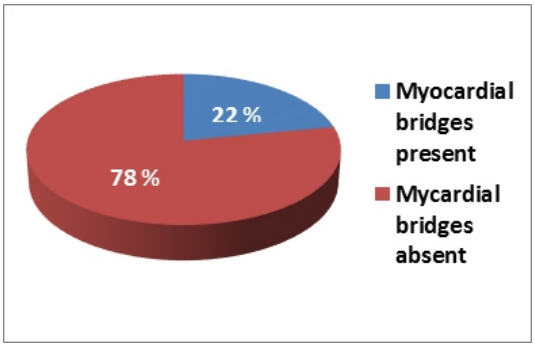


Figure 1 – Pie chart showing total percentage of myocardial bridges

Table 1. Prevalence of myocardial bridges – A gender based comparison

Gender	Myocardial bridges present		Myocardial bridges absent	
	Number	Percentage	Number	Percentage
Male	8	(24 %)	26	(76%)
Female	3	(19 %)	13	(81 %)
Total	11	(22 %)	39	(78 %)

Table 2 – Prevalence of myocardial bridges – comparative figures in literature

SL no	Authors	%
1	Geiringer[1]1951	22 %
2	Polacek[5] 1961	85.7%
3	Chen & Liao[4] 1965	76.2 %
4	Kramer et al[11] 1982	12 %
5	Irvin & Charleston12 1982	7.5- 9.7 %
6	Angelini et al $_2$ 1983	4.6- 8.3 %
7	Uusitalo et al [27] 2015	34%
8	Lee & Chen [18] 2015	25%
9	Present study	22%



Figure 2Myocrdial bridge on LAD



Figure 3 Deep dipping of LAD into myocardium

DISCUSSION

Myocardial bridging of the coronary arteries was described by Geiringer1. He observed the dipping of the subepicardial coronary arteries in to the myocardium for a varying distance and referred such arteries as "mural coronaries". He reported an incidence rate of 22% for this variation. He noticed the thin nature of intima of these arteries than corresponding epicardial arteries. Myocardial bridge, Intramural coronary artery, Mural coronary artery, Coronary artery overbridging and Myocardial loop are the termsused to designate essentially the same phenomenon.(Angelini et al) [2]. The incidence of myocardial bridging ranges widely, from 5% to 80% in autopsy studies, whereas angiography series have recorded incidences ranging from 0.5% to 12% (Polacek&Zochmeister) [3]. A high frequency incidence of 76 % was also documented by Chen and Liao[4].

Polacek[5] classified these bridges into two groups - ventricular muscular bridges and atrial muscular loops. According to him the muscular bridges formed by ventricular myocardium (usually 10 to 20 mm long, up to 5 mm thick, and rarely mentioned in the literature) are most frequent in the proximal half of the anterior descending branch (60.0 per cent), next most frequent in the oblique branch of the left coronary artery (18.5 per cent), and rarer (2.8 to 14.2 per cent) in other branches of the left and right coronary arteries. The muscular loops, formed by atrial myocardium (usually 10 to 15 mm. long, 100 to 300 μ thick, and not mentioned in the literature up to now) are most frequent in the first stretch of the circumflex branch of the left coronary artery (40.0 per cent), and in the terminal stretch of the right coronary artery (27.1 per cent).

Angiographic visualisation of the myocardial bridges in canine hearts followed by their postmortem examinations were done by Bloor and Lowman[6].

Mohlenkamp[7] in his review article summarize clinically relevant aspects of myocardial bridging with an emphasis on morphological and hemodynamic alterations and their representation in imaging techniques.

Ferreira et al [8] divided the myocardial bridging into two types: superficial anddeep muscle types. The former does not constrict the coronary flow during systole; whereas the latter may compress the coronary artery, reduce the flow and induce myocardial ischemia.

The milking effect of the myocardial bridges on the coronary arteries was described by Noble et al [9]. They suggested that the contraction of myocardial bridges might reduce the calibre of the coronary artery by more than 75%, and so in situations requiring a substantial oxygen supply to the myocardial cells, the ECG might present anomalies compatible with ischemia and lactate production. This is the basis for the hypothesis that the myocardial bridges may be the cause of myocardial ischemia.They categorized the systolic coronary narrowing into three classes: Grade 1 (systolic coronary narrowing <50%), Grade 2 (systolic coronary narrowing 50-75%) and Grade 3 (systolic coronary narrowing >75%).

Faruqui et al[10] reported two cases of symptomatic myocardial bridging of the left anterior descending artery which on angiog raphy recognized as systolic narrowing or milking effect of the affected vessel. The following factors have been postulated by them to account for the symptoms of myocardial ischemia in patients with myocardial bridges.

1 the unusual length of tunneled coronary segment;
2 the severity of systolic narrowing; and
3 tachycardia.

The longer the tunneled segment, more severe is the systolic narrowing of arteries. This in combination with tachycardia contributes to myocardial ischemia in the presence of myocardial bridging. Kramer et al11noticed the benign and frequent nature of myocardial bridges involving the left anterior descending artery and reported its occurrence in 12% of the cineangiograms of all "normal" patients, they studied.

The left anterior descending artery was the most commonly involved vessel in a study byIrvin & Charleston [12]. The prevalence of myocardial bridges in their study was 7.5%-9.7% They also reported a case in which a 20 years old woman experienced ventricular fibrillation while jogging and the cardiac catheterisation showed myocardial bridges with greater than 50% systolic narrowing of the left anterior descending artery, diagonal branch, the proximal right coronary artery and an anterior ventricular branch.

Schulte et al[13] reported a case of 46% intramyocardial tunneling of left anterior descending artery without any clinical or morphogenic evidence of myocardial ischemia and suggested that this extreme degree of left anterior descending artery tunneling was unlikely to cause myocardial ischemia.

The morphometric characteristics of the nuclei of the fibres of the myocardial bridges are different from those of the adjacent myocardial cells and the fibres of the myocardial bridges are less functional than those in the rest of the myocardium (Reig et al)[14]. The myocardial bridge is a risk factor for certain surgical intervention, in particular aorto-coronary bypasses that affect the anterior interventricular artery. This is because of the submerged portion of the artery is only a few millimetres from the right ventricle, and there is a risk of perforation during the surgical maneuvers to identify the artery (Vilallonga)[15].

Clinical suspicion of a myocardial bridgeshould be considered in all cases of typical or atypical chest pain, particularly inyoung patients with a low probability of atherosclerosis who are free from traditional cardiovascular risk factors and the prognosis of patients with myocardial bridges is not benign as it was believed to be in the

past(Ripa et al)[16].Daoud and Wafa 17 document that the coronary blood flow is decreased in the patients with myocardial bridges compared with the patients having normal coronary.As perLee& Chen's 18 reportsatherosclerosis preferentially develops immediately proximal to the bridged segment, likely due to alterations in shear stress, while the compressed segment itself is often spared.

The intima beneath the bridge is protected from atherosclerosis and the proximal segment is more susceptible to development of atherosclerotic lesions because of haemodynamic disturba nces..Myocardial bridging has been associated with angina, arrhythmia, depressed left ventricular function, myocardial stunning, early death after cardiac transplantation, and sudden death. (Alegria et al) [19].

Corban et al [20] opine that the haemodynamic impact of myocardial bridging depends on the thickness and length of the bridge, the orientation of the bridge relative to myocardial fibers, and the presence of loose connective or adipose tissue around the bridged segment . As per their viewpatients with myocardial bridging are often asymptomatic, but this anomaly may be associated with exertional angina, acute coronary syndromes, cardiac arrhythmias, syncope, or even sudden cardiac death.

The clinical diagnosis can be established by significant percent lumen diameter and area narrowing,increased flow velocity and by characterstic patterns such as the " half moon " on intravascular ultra sound and the early " fingertip phenomenon " on intra coronary Doppler (Bowrassa et al)21. Brushke et al 22 recommend Coronary Arteriography(CAG) and Computed Tomography Coronary Angiography (CTCA)to understand the pathophysiology of myocardial bridging.

Medical therapy with beta blockers and calcium channel blockers remain the main stay of treatment in symptomatic patients (Corban et al)20. Surgical intervention involves either myotomy or coronary artery bypass (Wu &Xu) [23]. Myotomy is a preferred surgical procedure for relieving the patients' symptoms, improving the coronary flow and alleviating the coronary artery compression secondary to myocardial bridging (Yaun SM)[24]. Wan & Wu 25did a comparative study of three treatment strategies (medical treat ment, coronary stenting, surgical myotomy) in patients with symptoms due to intramural coronaries and concluded that the surgical myotomy would be the best corrective method in patients with symptomatic myocardial bridging. Attaran et al [26]also recommends surgery which is performed either as supra-arterial myotomy and de-roofing of the muscle bands on- or off-pump, or as coronary artery bypass grafting of the affected coronary artery beyond the tunneled segment. He highlights the need of coronary artery bypass surgery in patients with extensive or deep myocar dial bridging.

Conclusion

Intramural tunneling of coronary artey is very common . Left anterior descending artery is the most affected vessel and it is commonly encounterd in it's middle segment. Present work shows a prevalence of 22% . There is no gender based variation in the incidence of myocardial bridging.Since the myocardial bridge may act as a predisposing factor of myocardial ishaemia as documented in the literature , awareness of the prevalence of myocardial bridging is very important in preventing the coronary artery disease. The significance of myocardial bridges should be taken into consideration before planning interventional procedures in symptomatic patients who are refractory to medical management as there is a risk ofperforation during the surgical revascularization as per many clinical studies.

References

1. Geiringer E. The mural coronary artery. Am Heart J. 1951; 41: 359-368.
2. Angelini P , Trivellato M , Donis J, Leachman RD. Myocardial Bridges – A review. ProgCardioVasc Dis. 1983; 26 (1): 75-88.
3. Polacek P,Zochmeister A. The occurrence and significance of myocardial bridges and loops on Coronary arteries. OpuscolaCardiologica. ActaFacultatis Medicae Univer sitatis Brunenses. Brno. University J.E. Purkinje.1968; 1-99.
4. Chen JN, Liao R. A study of the myocardial bridges on the coronary arteries in Chineese. ActaAnatSinica.1965; 8: 106-12.
5. PolacekP. Relation of myocardial bridges and loops on the coronaryarteries to coronary occlusions. Am Heart J. 1961; 61(1): 44-52.
6 Bloor CM, Lowman RM. Myocardial bridges in coronary angiography. Am Heart J. 1963; 65: 195-199.
7 Möhlenkamp S, Hort W, Ge J, Erbel R. Update on myocardial bridging. Circulation. 2002;106(20):2616-22.
8 Ferreira AG Jr, Trotter SE, König B Jr, Décourt LV, Fox K, Olsen EG. Myocardial bridges-morphological and functional aspects. Br Heart J. 1991;66(5):364-7.
9 Noble J, Bourassa MG, Petitclerc R, Dyrdra I. Myocardial bridging and milking effect of the left anterior descending artery - Normal variant or obstruction ?. Am J Cardio. 1976; 37(7):993-999.
10 Faruqui AMA., Maloy WC, Felner JM, Schlant RC, Logan WD, Symbas P. Symptomatic myocardial bridging of coronary artery. Am J Cardiol. 1978; 41: 1305 – 1310.
11 Kramer JR., Kitazume H, Proudfit ,Sones FM. Significance of isolated coronary bridges – Benign and frequent condition involving LAD. Am Heart J. 1982; 103: 283- 288.
12 Irvin RG , Charleston. Angiographic prevalence of myocardial bridging. Chest. 1982; 81(2): 198-202.
13 Shulte MA, Waller BF, Hull MT,Pless JE. Origin of the Left anterior descending artery from the right aortic sinus with intramyocardial tunneling to the left side of heart via the ventricular septum - A case against clinical and morphological significance of myocardial bridging. Am Heat J. 1985; 110: 499-501.
14 Reig J, Ruiz C ,Moragas A.Morphometrical analysis of myocardial bridges in children with ventricular hypertrophy. Pedcardiol. 1990; 11: 186-190.
15 Vilallonga JR. Anatomical variations of the coronary arteries - The most frequent variations. Eur J Anat. 2003; 7(1): 29-41.
16 Ripa C,Melatini MC,Olivieri F, Antonicelli R. Myocardial Bridging - A forgotten cause of acute coronary syndrome – a case report. Int J Angiol. 2007; 16(3) Autumn: 115-118.
17 DaoudEM ,WafaAA. Does isolated myocardial bridge really interfere withcoronary blood flow ?. The Egyptian Heart Journal. June 2013; 65(2): 65-70.
18 Lee MS,Chen CH. Myocardial Bridging - An upto Date review. J Invasive Cardiol. 2015 Nov27; (11): 521-528.
19 Alegria JR, Herrmann J, Holmes DR, Lerman A, Rihal CS . Myocardial ridging. Eur Heart J. 2005; 26(12): 1159-1168.
20 Corban MT, Hung OY, Eshtehardi P, Arzrumly ER, Daniel MM, Mekonnen G, Timmis LH, Lutz J, Gyton RA, Samady H. Myocardial Bridging – Contemporary understanding of pathophysiology with implications for diagnostic and therapeutics strategies. Journal of the American College of Cardiology. June 2014; 63(22): 2346-2355.
21 Bowrassa MG, Butnaru A, Lesperance J, Tardif JC.Symptomatic myocardial bridges - Overview of ischaemic mechanisms and current diagnostic and treatment strategies. Journal of American College of Cardiology. 2003 ; 41 (3): 351-359.
22 Bruschke AVG , Veltman CE, Graff MA, Vliegen HW. Myocardial bridging – what have we learned in the past and will new diagnostic modalities provide new insights?. Nerth Heart J. 2013; 21(1): 6-13.
23 Wu QY, Xu ZH. Surgical treatment of myocardial bridging - report of 31 cases. Chin Med J. 2007; 120: 1689-1693.
24 Yuan SM. Myocardial Bridging. Braz J Cardiovascu Surg. Sao Josedo Rio Preto. Jan/ Feb 2016; 31(1):60-62.
25 Wan L , Wu Q. Myocardial bridge – surgery or stenting ?. Interact Cardio VascThorac Surg. 2005; 4(6): 517-520.
26 Attaran S, Moscarelli M, Athanasiou T, Anderson J. Is coronary artery bypass grafting an acceptable alternative to myotomy for the treatment of myocardial bridging ?. Interact CardioVascuThorac Surg. 2013; 16(3); 347- 349.
27 Uusitalo V, Saraste A, Pietila M, Kajander S, Bax JJ, Kunuti J. Thefunctional effects of intramural course of coronary arteries and its relation to coronary atherosclerosis. JACC Cardiovasc Imaging. 2015; 8(6): 694-704.