Original Article

The Angiographic Aspects of Myocardial Bridges in Turkish Patients who have Undergone Coronary Angiography

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Abstract

Introduction: Little is known of the clinical significance of myocardial bridges, which may be recognised as the narrowing of the systolic coronary artery as seen in an angiography. In this study, our goal was to review the literature information about the anatomic aspects, the clinical manifestations and implications, and the angiographic characteristics. Materials and Methods: The angiographic data of 7200 adult patients undergoing coronary angiography were retrospectively analysed for the diagnosis of myocardial bridge. The main angiographic evidence of a myocardial bridge that we required was the narrowing of a systolic coronary artery resulting in at least 50% reduction of lumen diameter in comparison with the diastolic phase. All coronary angiograms were reviewed independently by at least 2 of the authors and the case was included only if there was a consensus that the myocardial bridge resulted in 50% narrowing or more. Results: Myocardial bridge was present in 29 (0.4%) of the 7200 coronary angiographies. The location of the myocardial bridge was in the left anterior descending coronary artery in 28 cases (96.5%), and the left circumflex coronary artery in 1 case (3.4%). Myocardial bridge was most common in the middle segment of the left anterior descending coronary artery (78.5 %). Each of these patients with myocardial bridge was referred for angiography because of symptom of chest pain alone or symptom of chest pain, palpitations and dyspnoea. Of the 29 patients with myocardial bridge, 2 patients without any symptom, demonstrated ischaemia as assessed by Tc-99m MIBI myocardial perfusion scintigraphy. Conclusion: Chest pain was the common reason for angiography in patients with myocardial bridge. The incidence of myocardial bridge may vary according to population. Myocardial bridge is more frequently found in the middle segment of the left anterior descending coronary artery.

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Key words: Angiography, Myocardial bridge, Population

Introduction

Myocardial bridge, intramural coronary artery, coronary artery over bridging and myocardial loop are essentially the different terms used to designate the same phenomenon. Myocardial bridge was first described by Reyman in 1737[1] as an anatomical curiosity – the overlaying of the left anterior descending coronary artery by a myocardial bridge. In 1960, myocardial bridge was described angiographically as a systolic narrowing of the left anterior descending coronary artery by Portsmann and Iwing[2] as seen in a 19-year-old patient. Intervention cardiologists now generally agree that angiographically, the systolic narrowing compression of the arterial lumen is caused by a myocardial bridge.[3-7]

Our goal was to determine the frequency, angiographic characteristics, anatomical aspects and clinical manifestations and possible implications of myocardial bridges in a large population of adults undergoing coronary angiography in our centre.

Materials and Methods

Seven thousand and two hundred adult patients who underwent diagnostic cardiac angiography from January 2004 to January 2005 at Sani Konukoglu Medical Center were retrospectively evaluated to detect myocardial bridges. Relevant data from the charts and catheterisation reports were collected. Coronary angiography was performed using Judking and Sones techniques in standard projections. The

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main angiographic evidence of a myocardial bridge that we required was the narrowing of a systolic coronary artery resulting in at least 50% reduction of lumen diameter in comparison with the diastolic phase. All coronary angiograms were reviewed independently by at least 2 of the authors and the case was included only if there was a consensus that the myocardial bridge resulted in 50% narrowing or more.

Results

Of the 7200 patients studied, 1440 (20%) had no evidence of angiographically significant coronary artery disease. Myocardial bridge was present in 29 of the 7200 coronary angiographies reviewed, constituting an incidence of 0.4%. The location of the myocardial bridge was in the left anterior descending coronary artery in 28 cases (96.5%) (Fig. 1), and in the median branch of the left circumflex coronary artery in only 1 case (3.4%) (Fig. 2) (Table 1).

The middle thirds of the left anterior descending coronary artery was the most common site (22 of 28 cases, 78.5%). Involvement of the distal half of this coronary artery was observed in 5 cases (17.8%). Myocardial bridge covered the middle and distal segments of the left anterior descending coronary artery in only 1 case (3.5%) (Fig. 3). The length of myocardial bridge ranged from a discrete segment of less than 1 cm to a diffused involvement of more than one third of the artery. The greater length of the myocardial bridge covered the mid portion and the beginning distal portion of the left anterior descending coronary artery completely (Fig. 3).

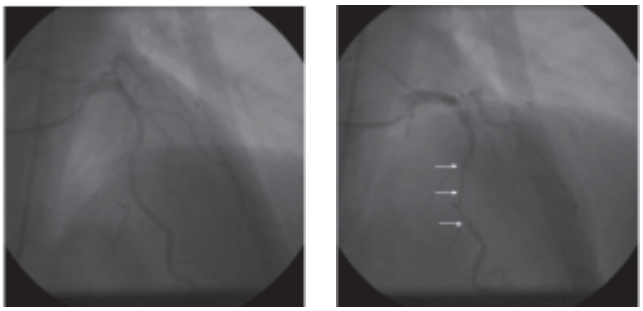

Fig. 1. The myocardial bridge covered the left anterior descending coronary artery.
A: Left anterior oblique projection of the left anterior descending coronary artery during diastole.
B: Left anterior oblique projection of the left anterior descending coronary artery during systole, with arrows indicating the segment of systolic distal bridging.

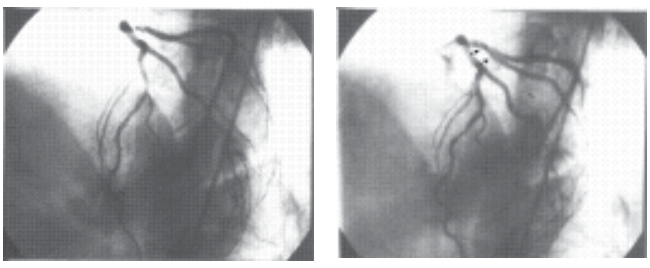

Fig. 2. The myocardial bridge was found over the median branch of the left circumflex coronary artery.
A: Left anterior oblique projection of the left circumflex coronary artery during diastole.
B: Left anterior oblique projection of the left circumflex coronary artery during systole, with arrows indicating the segment of systolic proximal bridging.

Angiographic and clinical data in patients with demonstrable myocardial bridges are seen in Table 1. Myocardial bridge occurred in 5 females and 24 males. Their ages ranged from 28 to 75 years, with a mean age of 52 years. Each of these patients with myocardial bridge was referred for angiography because of symptom of chest pain alone or symptoms of chest pain, palpitations and dyspnoea. Atherosclerotic occlusive disease was present in 23 patients (79.3%), 15 had atherosclerosis in the proximal region to myocardial bridge while 7 had atherosclerosis in the distal region to myocardial bridge and 1 had atherosclerosis in the proximal and distal regions to myocardial bridge. Of the 23 patients with atherosclerosis, 12 patients had 60% or greater obstruction of the left anterior descending coronary artery. Of the 29 patients, only 1 had hypertrophic obstructive cardiomyopathy. The valvular disease was present in 5 patients and 1 patient had Wolff Parkinson White syndrome. Of the 29 patients, 2 patients had no other significant heart diseases. Their resting electrocardiogram was normal but these patients demonstrated ischaemia when assessed by Tc-99m MIBI myocardial perfusion scintigraphy in the distribution of the culprit lesion.

Discussion

As shown in Table 2, the incidence of myocardial bridge has been reported to be 0.5% to 7.5% in angiographic studies.[3-7] The angiographic incidence of myocardial bridge

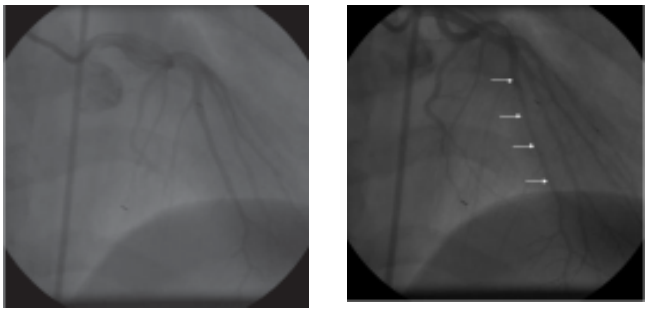

Fig. 3. The greater length of the myocardial bridge completely covered the mid portion and the beginning distal portion of the left anterior descending coronary artery.
A: Left anterior oblique projection of the left anterior descending coronary artery during diastole.
B: Left anterior oblique projection of the left anterior descending coronary artery during systole, with arrows indicating the segment of systolic mid and distal bridging.

Table 1. Angiographic and Clinical Data in Patients With Demonstrable Myocardial Bridges

Patient	Age	Sex	Clinical presentation	Clinical diagnosis	CAD R L Cx	Site of MB
1	54	M	Chest pain, dyspnoea	CAD	X X X	LAD (Mid)
2	28	M	Chest pain	WPW Syndrome vent. fibrillation	0 0 0	LAD (Mid Dis)
3	33	M	Chest pain	CAD, RCA rudiment	0 X 0	LAD (Mid)
4	46	F	Dyspnoea	Aortic valve insufficiency	0 0 0	LAD (Dis)
5	55	M	Palpitation	CAD, RCA rudiment	0 X 0	LCx
6	60	M	Chest pain	CAD	X X X	LAD (Mid)
7	42	M	Chest pain, palpitation	Absence of any heart diseases	0 0 0	LAD (Dis)
8	50	M	Chest pain, dyspnoea	CAD	X X 0	LAD (Mid)
9	52	M	Dyspnoea	CAD	X X X	LAD (Mid)
10	46	F	Chest pain	CAD	0 X X	LAD (Mid)
11	55	M	Chest pain	CAD	X X X	LAD (Mid)
12	60	M	Chest pain	CAD, mitral valve insufficiency	0 X 0	LAD (Dis)
13	72	M	Chest pain	CAD	X X X	LAD (Mid)
14	47	M	Chest pain	CAD	0 X 0	LAD (Dis)
15	69	M	Chest pain	CAD	X X X	LAD (Dis)
16	71	M	Chest pain	CAD	X X 0	LAD (Mid)
17	62	M	Chest pain	CAD	X X 0	LAD (Mid)
18	43	M	Chest pain	CAD	X X 0	LAD (Mid)
19	53	M	Chest pain	CAD	X X 0	LAD (Mid)
20	50	M	Chest pain	CAD	X X X	LAD (Mid)
21	50	M	Chest pain	CAD	X X 0	LAD (Mid)
22	41	M	Chest pain, dyspnoea	Absence of any heart diseases	0 0 0	LAD (Mid)
23	60	M	Chest pain	CAD	X X X	LAD (Mid)
24	45	F	Chest pain	CAD	0 X X	LAD (Mid)
25	35	M	Chest pain, dyspnoea	Mitral valve replace	X X O	LAD (Mid)
26	75	F	Chest pain, palpitation	Aortic valve insufficiency	0 0 0	LAD (Mid)
27	56	M	Chest pain	CAD	X X X	LAD (Mid)
28	52	F	Chest pain	CAD	X X 0	LAD (Mid)
29	47	M	Chest pain	Mitral valve insufficiency	0 0 0	LAD (Mid)

CAD: coronary artery disease: LAD: left anterior descending coronary artery; LCx: left circumflex coronary artery; RCA: right coronary artery

reported by Irvin[6] was higher than that found in previous angiographic studies. He explained the causes of the higher prevalence in his study as follows: (1) the arteriograms were retrospectively reviewed for the specific purpose of assessing the frequency of myocardial bridges, (2) no percentage of systolic narrowing was specified for the designation of myocardial bridge in his series and (3) the technologic advances in cineangiography, which had occurred in the past few years, have allowed more precise delineation of the arterial diameters.

The frequency of myocardial bridges in Turkish patients undergoing coronary angiography was reported as 0.4% (29 cases) here; this was the lower angiographic incidence. Soran et al[8] reported that the frequency of myocardial bridges in 2547 Turkish patients undergoing coronary angiography was 1%. Their incidence was higher but their consensus in the degree of systolic compression was 1% to 100%. When the degree of systolic compression was 50% or more, the frequency of myocardial bridges was 0.5% in their study. We can then say that the frequency of myocardial

Table 2. The Incidence and Site of Myocardial Bridges in Angiographic Studies

Noble et al[3] 1976	5250	27	0.5	LAD
Ishimori et al[4] 1977	313	5	1.6	LAD
Greenspan et al[5] 1980	1600	14	0.9	LAD
Irvin[6] 1982	465	35	7.5	LAD
Angelini et al[7] 1983	1100	60	5.5	LAD + RCA
Our findings	7200	29	0.4	LAD + LCx

LAD: left anterior descending coronary artery; LCx: left circumflex coronary artery; MB: myocardial bridge; RCA: right coronary artery

bridges in Turkish patients undergoing coronary angiography was approximately 0.5%. The frequency of myocardial bridges in Turkish patients was the lowest. In our study, a possible explanation for the low frequency is the fact that a 50% systolic narrowing was required for the designation of myocardial bridge. Another tempting speculation would have been that there might be genetic variations that may contribute in the different incidence of myocardial bridges among different populations.

In the present study, 28 patients (96.5%) had myocardial bridge of the left anterior descending coronary artery and 1 had myocardial bridge of the median branch of the left circumflex coronary artery (3.4%). Myocardial bridges are usually found over the left anterior descending coronary artery; they are very rarely found over the right coronary artery or the left circumflex coronary artery. Angelini et al[7] reported that out of 61 patients with myocardial bridge, only 1 (a patient of Chinese descent) had an additional myocardial bridge of the posterior descending branch of the right coronary artery. Myocardial bridges over the left circumflex coronary artery are also rare in angiographic studies. A case was reported by Okmen et al[9] in an angiographic study. Suprisingly, this patient was Turkish. In this study, 1 patient with a myocardial bridge of the left circumflex coronary artery was observed.

The most frequent site of myocardial bridge is found in the middle segment of the left anterior descending coronary artery.[4,6,7] In this series, out of 28 patients with myocardial bridge of the left anterior descending coronary artery, 22 (78.5%) had myocardial bridge of the middle segment of the left anterior descending coronary artery, while 5 (17.8%) had myocardial bridge of the distal segment of the left anterior descending coronary artery.

Because myocardial bridging is a common finding at autopsy of normal subjects, it was thought to be a benign anatomic variation. However, the common symptoms associated with myocardial bridge can range from angina pectoris and myocardial infarction to ventricular tachycardia and sudden death.[3,8,10,11] In this study, out of 29 patients with myocardial bridge, 2 patients who had myocardial bridge of the left anterior descending coronary artery but no cardiovascular disease had angina on exertion. They had no electrocardiographic abnormalities when at rest or any cardiovascular disease. Although this malformation is present since birth, symptoms do not usually develop before the third decade; the reason for this is not clear.

Is an intramural coronary artery a simple anatomic or a pathologic variant? At autopsy, Ferreira et al[12] assessed the anatomy of myocardial bridges in 90 hearts from subjects (age range, stillbirth to 84 years) who did not have a history of established cardiac disease or a cardiac-related death. Myocardial bridges were identified in 50 hearts (55.6%), 31 of which were classified as "superficial" (i.e. left anterior descending coronary artery was in the interventricular groove, and before it deviated to the apex of the heart, it was crossed by the muscle bundle perpendicularly or at an acute angle). The other 10 myocardial bridges were classified as "deep" (i.e. left anterior descending coronary artery deviated toward the right ventricle and was situated deeply on the interventricular septum, where it was crossed transversely, obliquely, or helically by a longitudinal muscle bundle arising from the apex of the right ventricle and inserting into the interventricular septum). The superficial variant may not constrict the tunnelled artery during systole; however, the deep variant, because of its relation with the left anterior descending coronary artery, could twist the artery, thus compromising its diastolic flow and producing ischaemia.

To establish whether an intramural left anterior descending coronary artery is a simple anatomic or a pathologic variant, Morales et al[10] studied 39 hearts with myocardial bridges but no evidence of other cardiac abnormalities. Of these hearts, 22 cases had gross or microscopic alterations (or both), such as interstitial fibrosis, replacement fibrosis, contraction-band necrosis, or increased vascular density, in the areas of focal fibrosis in the myocardium supplied by the intramural left anterior descending coronary artery. Each of these 22 hearts had an intramural left anterior descending coronary artery placed deeply within the ventricular wall and possible attenuation of collateral blood flow because of the intramural course of the posterior descending coronary artery, other epicardial coronary arteries, or a small right coronary artery. The myocardial changes suggested that a deep intramural left anterior descending coronary artery is abnormal and not an anatomic variant. Furthermore, the deep intramural left anterior descending coronary artery may be associated with sudden death: 13 of the 22 hearts were from victims of sudden death, 6 of whom died suddenly during exercise. Although a superficial bridge was thought to be hemodynamically non-significant, a recent report implicated a superficial

myocardial bridge as a cause of thrombus formation and subsequent myocardial infarction in a young athlete.[17] Ozbag and Kervancioglu[13] investigated the perivasculary space under the myocardial bridges in dog, sheep, goat and human hearts and suggested that the distance between the myocardial bridges and coronary artery was crucial to determine how much force was exerted on the coronary artery. If the distance between the 2 structures were far enough, the force exerted on the blood vessel would be less likely to cause problems.

A decreased incidence of atherosclerotic changes at the level of myocardial bridge was reported in related literature.[7,14] Using intracoronary ultrasonography and pressure measurements, Ge et al[14] studied a patient who had myocardial bridge of the left anterior descending coronary artery and discovered that the pressure in the left anterior descending coronary artery segment proximal to the myocardial bridge was higher (160/26 mm Hg) than that of a normal proximal segment (126/68 mm Hg). The pressure distal to the myocardial bridge was 68/30 mm Hg. The authors concluded that the pressure proximal to the myocardial bridge was higher than the aortic pressure, and the disturbance of blood flow and high wall stress proximal to the myocardial bridge were the main contributors to the development of atherosclerosis in the proximal segment. In our series, out of 29 patients with myocardial bridge, 23 (76.6%) had atherosclerosis in one or more coronary artery. Out of 23 patients with atherosclerosis in the left anterior descending coronary artery, 15 (65.2%) had atherosclerosis in the proximal to the myocardial bridge region while 7 (30.4%) had atherosclerosis in the distal to the myocardial bridge region and 1 (4.3%) had atherosclerosis in the proximal and distal regions to the myocardial bridge. The finding of atherosclerotic plaques occlusion with a myocardial bridge was similar to the findings in accord with the literature reviewed.

Noble et al[3] and Ishimori et al[4] observed the relationship between hypertrophied myocardium and myocardial bridge. In their series, they found 4 out of 5 cases with left ventricular hypertrophy, and 4 out of 11 cases with left ventricular hypertrophy. They suggested that hypertrophied myocardium might compound the extent of systolic compression. In this study, 15 out of 29 patients had left ventricular hypertrophy on their echocardiographs. More interestingly, 1 of the 29 patients had hypertrophic obstructive cardiomyopathy.

The conclusions of this study: (1) chest pain was the common reason for angiography in the patients with myocardial bridge, (2) the incidence of myocardial bridge may vary according to population, (3) myocardial bridges were usually located over the left anterior descending coronary artery; they rarely covered other coronary arteries, (4) myocardial bridges over the left anterior descending coronary artery usually covered the middle segment of the left anterior descending coronary artery and (5) although most patients were asymptomatic, myocardial bridges could sometimes be a cause of angina.

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