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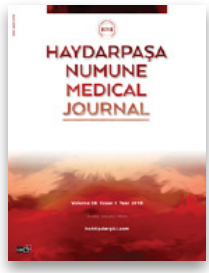

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ORIGINAL ARTICLE

Prevalence of Myocardial Bridge and Possible Associated Variables with Coexisting Coronary Atherosclerosis and Acute Coronary Syndrome

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Abstract

Introduction: The present study aims to evaluate the prevalence of myocardial bridging (MB) and investigate patient and bridge-related factors that may be associated with an increased tendency for atherosclerosis and acute coronary syndrome.

Methods: Consecutive coronary angiography recordings that were recorded between 01/01/2013 and 01/01/2016 were retrospectively evaluated in this study. Data of consecutive patients with MB were obtained from patient files. Patients with MB were grouped according to the presence of significant atherosclerosis in any coronary artery and the presence of significant atherosclerosis proximal to bridge. Patients with isolated MB were also sub-grouped according to their presentation with the acute coronary syndrome. Demographic, clinical and angiographic parameters were compared between groups.

Results: There were a total of 75 patients with MB, with an overall prevalence rate of 1.07%. MB patients without coexisting significant atherosclerotic lesion had longer bridge length and more severe stenosis rate (21.4±9.9 mm vs. 17.2±7.6 mm, p=0.045; 73.0±12.5% vs. 65.6±13.0%, p=0.015, respectively). Diabetes mellitus was the only risk factor that was more prevalent in MB patients with significant coexisting atherosclerotic lesions. MB segment of patients with proximal significant atherosclerosis was significantly shorter compared with the length of patients without significant proximal atherosclerosis (16.0±7.4 mm vs 20.7±9.5 mm, p=0.05). The presentation as an acute coronary syndrome was more prevalent in patients with significant atherosclerosis compared to patients with isolated MB (68.8% vs. 46.5%, p=0.045). There was no significant discriminative variable for presentation as acute coronary syndrome in patients with isolated MB.

Discussion and Conclusion: The prevalence rate of MB in our study is in agreement with the previous angiographic studies reported from Turkey. Coexisting atherosclerotic lesions seem to be primarily involved in the pathogenesis of acute coronary syndrome and ischemic symptoms that had necessitated coronary angiography.

Keywords: Atherosclerosis; acute coronary syndrome; coronary angiography; myocardial bridging.

Myocardial bridging (MB) is a coronary abnormality characterized by the intramural course of a part of a major coronary artery inside the myocardial tissue [1, 2]. A coronary segment within the myocardium is compressed during systole. The prevalence of MB has been reported to vary between 0.5% and 33% in the literature [3]. Although MB has been considered as a benign condition, it has also been reported to be associated with ischemia and acute coronary syndromes, arrhythmias (including supraventricular tachycardia and ventricular tachycardia), exercise-in-

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duced atrioventricular conduction block and sudden death [1, 2]. MB has also been associated with increased propensity to atherosclerosis by alterations in shear stress [2].

The present study aims to evaluate the prevalence of MB by retrospectively evaluating coronary angiography recordings in our institution. We also aimed to evaluate possible predictors for a possible association between MB and significant coronary atherosclerosis and/or presentation with the acute coronary syndrome.

Materials and Methods

Patients

The study population consisted of 75 patients who were found to have MB after retrospective evaluation of consecutive coronary angiographic recordings of 7010 patients who underwent coronary angiography between 01/01/2013 and 01/01/2016 in our institution. Demographic, clinic and angiographic characteristics of patients with MB were obtained from patient files and recorded for analysis. The presence of classical cardiovascular risk factors was also noted for each patient.

Patients with MB were grouped according to the presence of significant coronary atherosclerosis and/or previous history of myocardial revascularization in any of the coronary arteries. Demographical and clinical findings, cardiovascular risk status and angiographic characteristics of MB were compared between the two groups. In the second step, patients were grouped according to the presence of significant atherosclerosis in the segment proximal to MB and comparison was made between groups for the same variables. In the third step, patients with MB but without coexisting, significant atherosclerosis were sub-grouped according to their presentation as acute coronary syndrome at the time of coronary angiography. The above-mentioned variables were compared between MB patients who had presented with the acute coronary syndrome and patients who had undergone coronary angiography as an elective procedure.

Coronary Angiography

Coronary angiographies were performed by standard Judkins' technique using the femoral or radial route. The compression of the coronary artery segment during systole and dilation during diastole was accepted as MB. Siemens QuantCor QCA (ACOM.PC 5.01, Siemens Medical Systems Inc., Malvern, Pennsylvania) software was used for quantitative assessment of MB and coexisting atherosclerotic lesions. Lesion and/or bridge length, minimal lumen diameter and stenosis rate were recorded for each patient. Stenosis rate of the bridge was evaluated at end-systole, which was accepted to be end of T wave on electrocardiography. Angiographically significant atherosclerosis was defined as a stenosis rate of more than 50%.

Cardiovascular Risk Factors

Diabetes mellitus was diagnosed when patients were taking hypoglycemic medications or when, in the absence of treatment, fasting blood glucose levels were higher than 126 mg/dL in two consecutive determinations [4]. Hyperlipidemia was defined as fasting total serum cholesterol more than 240 mg/dL and/or when patients were taking an oral lipid-lowering agent. Subjects taking antihypertensive drugs or showing a systolic blood pressure of 140 mmHg or more and/or diastolic blood pressure of 90 mmHg in their hospital records were defined as hypertensive. Patients smoking at least one cigarette daily for one year within the last five years were considered smokers.

Statistical Analysis

Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA) version 15.0 was used for data analysis. Distribution of data was assessed using the one-sample Kolmogorov-Smirnov test. Values displaying normal distribution were expressed as the mean±SD, while values not displaying normal distribution were expressed as median (interquartile range). The significance of difference between groups regarding numeric variables with normal distribution was tested with independent samples Student's t-test. The significance of difference between groups regarding numeric variables without normal distribution was tested using the Mann-Whitney U test. The significance of difference between groups for categorical parameters was assessed using the chi-square test. A p-value of less than 0.05 was considered significant.

Results

There were a total of 75 patients with MB and the overall prevalence of myocardial bridging was 1.07% in our study. MB was located at mid (n: 62, 82.6%) or distal segments of LAD (n=13, 17.4%) in all patients. Eleven patients (14.6%) had a past history of percutaneous myocardial revascularization for coexisting atherosclerotic lesions in any of the coronary arteries. Thirty-two patients (42.7%) had a coexisting critical atherosclerotic lesion and/or chronic total occlusion and/or history of myocardial revascularization in any of the coronary arteries. Remaining 43 patients (57.3%) were observed to be free of coexisting significant

atherosclerotic lesions. Demographic findings and cardiovascular risk factor profiles of MB patients with and without coexisting significant atherosclerosis are presented in Table 1. Diabetes mellitus was the only risk factor that was more prevalent in MB patients with significant coexisting atherosclerotic lesions (Table 1). Angiographic measurements of MB are presented in Table 2. MB patients without coexisting significant atherosclerotic lesion had longer bridge length and more severe stenosis (Table 2). Twenty-two patients (68.8%) in group with atherosclerosis and 20 patients (46.5%) in group without atherosclerosis had presented with the acute coronary syndrome at the time of coronary angiography (p=0.045) (Table 1). Twenty patients with an acute coronary syndrome in the group with atherosclerosis had undergone successful percutaneous coronary intervention while coronary artery bypass surgery had been applied to the remaining two patients due to the presence of significant multivessel disease. None of the acute coronary syndrome patients in the group with MB free of significant atherosclerosis had undergone percutaneous coronary intervention, and they were discharged with appropriate medical therapy after an uneventful in hospital course. In general, none of the MB segments in the study population had undergone percutaneous intervention. Eight patients (out of 22 patients with the acute coronary syndrome) in atherosclerosis group had presented with acute ST-elevation myocardial infarction (STEMI), whereas none of the patients in group without significant atherosclerosis presented with STEMI at the time of coronary angiography (p=0.001) (Table 1). All patients presenting with STEMI had undergone successful primary angioplasty with complete resolution of ST elevation.

There were 18 patients with significant atherosclerosis on LAD proximal to the bridging segment. There was no significant difference regarding the frequency of cardiovascular risk factors between patients with and without significant atherosclerosis proximal to bridge. However, the ratio of females was significantly higher in the group with significant atherosclerosis proximal to the bridge (Table 3). MB segment of patients with proximal significant atherosclerosis was significantly shorter compared with the length of patients without significant proximal atherosclerosis (Table 3). There were no significant differences between groups regarding minimal diameter or systolic stenosis rate of MB (Table 3).

Patients with MB but without coexisting significant atherosclerotic lesions were separately evaluated for investigating the effect of MB on the occurrence of acute coronary syndrome. Demographic findings and cardiovascular risk factor profiles of MB patients free of significant atherosclerotic lesions are presented in Table 4 concerning their presentation with acute coronary syndrome. There were no significant differences between groups regarding age, gender and frequency of conventional cardiovascular risk factors (Table 4). The patients who presented with acute coronary syndrome had longer MB with smaller minimal diameter compared with the ones of patients without acute coronary syndrome; however, the difference failed to reach statistical significance (Table 4).

Discussion

The prevalence of MB was 1.07% in our study. All of the bridges were observed to be in mid or distal LAD. Patients with coexisting significant atherosclerosis in any of coronary arteries had a higher frequency of diabetes, and their MB was shorter with less degree of systolic stenosis rate compared with MB patients free of coexisting significant

Table 1. Demographic findings and cardiovascular risk factor profiles of the myocardial bridge patients with and without coexisting significant atherosclerotic lesion

	With significant atherosclerosis (n=32)	Without significant atherosclerosis (n=43)	p
Age (years)	61.3±13.7	56.5±11.1	0.32
Gender (male, %)	26 (81.2)	36 (83.7)	0.50
Hypertension, n (%)	14 (43.8)	17 (39.5)	0.44
Diabetes mellitus, n (%)	12 (37.5)	6 (14)	0.019
Smoking, n (%)	18 (56.2)	22 (51.2)	0.42
Hyperlipidemia, n (%)	11 (34.4)	14 (32.6)	0.53
Presentation with the acute coronary syndrome, n (%)	22 (68.8)	20 (46.5)	0.045
Presentation with STEMI, n (%)	8 (25.0)	0 (0)	0.001

STEMI: ST elevation myocardial infarction.

Table 2. Angiographic measurements related with myocardial bridge in patients with and without significant atherosclerosis in any of the coronary arteries

	With significant atherosclerosis (n=32)	Without significant atherosclerosis (n=43)	p
Length (mm)	17.2±7.6	21.4±9.9	0.045
Minimal diameter (mm)	2.3±0.4	2.4±0.4	0.045
Stenosis rate (%)	65.6±13.0	73.0±12.5	0.015

Table 3. Demographic findings, cardiovascular risk factor profiles and bridge-related angiographic measurements of patients with and without significant atherosclerosis proximal to myocardial bridge

	Significant atherosclerosis proximal to bridge (n=18)	No significant atherosclerosis proximal to bridge (n=57)	p
Age (years)	16.0±7.4	20.8±9.5	0.09
Gender (male, %)	12 (66.7)	50 (87.7)	0.05
Hypertension, n (%)	10 (55.6)	21 (36.3)	0.13
Diabetes mellitus, n (%)	7 (38.9)	11 (19.3)	0.08
Smoking, n (%)	10 (55.6)	30 (52.6)	0.52
Hyperlipidemia, n (%)	6 (33.3)	19 (33.3)	0.61
Length (mm)	16.0±7.4	20.7±9.5	0.05
Minimal diameter (mm)	2.22±0.4	2.4±0.4	0.08
Stenosis rate (%)	66.3±14.3	71.0±12.7	0.19

atherosclerosis. There were more female patients who had significant atherosclerosis proximal to the bridging segment. In addition, patients with significant atherosclerosis proximal to bridge had a shorter bridge segment were compared with patients without significant atherosclerosis proximal to the bridge. Demographic, clinic and angiographic parameters were similar between isolated MB patients who presented with and without acute coronary syndrome.

The prevalence rate of MB in our study is in agreement with the previous angiographic studies reported from Turkey. Cay et al.[3] reported a prevalence rate of 1.22%. They observed that 96.5% of MB was located in LAD. Duygu et al.[5] reported a prevalence rate of 1.13%, with 97.2% of bridging observed in LAD.

There are multiple proposed mechanisms for ischemia related to MB [2]. Doppler flow and pressure measurement studies in symptomatic MB revealed a persistent decrease in diastolic vessel diameter, an increase in blood flow velocities, retrograde flow and a reduced flow reserve. A higher degree of systolic narrowing was associated with a higher degree of decrease in flow and flow reserve [6]. In addition, it has been suggested that there may be a tendency for accelerated atherosclerosis development proximal to the bridged segment [7]. Impairment of endothelial cell function and morphology has been shown in segments proximal to tunneled segment with increased secretion of vasoactive mediators [8, 9]. The hemodynamic effect of bridging on proximal segments has been suggested to be the culprit factor for endothelial functional changes [2]. Studies have shown that the tunneled segment is spared from endothelial changes associated with increased atherosclerosis with thinner intima and abundance of smooth muscle cells in the vascular wall [2]. Intravascular ultrasound (IVUS) studies have shown the predilection for atherosclerotic plaque formation proximal to the tunneled segment and sparing of the bridged segment from atherosclerosis [2]. Systolic kinking of bridged segments with trauma to the intima and damage to the endothelium may predispose to the development of acute coronary syndrome in patients with MB [1, 2].

Our observation of shorter bridge length with less degree of systolic compression in patients with significant atherosclerosis in any of the coronary arteries is in contrast with the findings of Duygu et al. [5] They reported an increased systolic narrowing rate in MB patients with coexisting coronary atherosclerosis. Length of MB was similar between MB patients with and without coronary atherosclerosis in their study. Coexisting atherosclerotic lesions seem to be primarily involved in the progression of ischemic symptoms that

Table 4. Demographic findings, cardiovascular risk factor profiles and bridge-related angiographic measurements of isolated myocardial bridge patients who presented with and without the acute coronary syndrome

	Acute coronary syndrome (n=20)	Without acute coronary syndrome (n=23)	p
Age (years)	54.4±10.0	58.5±11.8	0.42
Gender (male, %)	18 (90.0)	18 (78.3)	0.27
Hypertension, n (%)	8 (40)	9 (39.1)	0.60
Diabetes mellitus, n (%)	1 (5)	5 (21.7)	0.13
Smoking, n (%)	13 (65)	9 (39.1)	0.06
Hyperlipidemia, n (%)	6 (30)	8 (34.8)	0.50
Length (mm)	25.8±11.4	17.7±6.5	0.08
Minimal diameter (mm)	2.4±0.5	2.5±0.3	0.09
Stenosis rate (%)	71.8±14.0	74.1±11.2	0.21

had necessitated coronary angiography in patients with significant coronary atherosclerosis in our study. However, isolated MB patients had longer bridge length with more severe compression, which might have caused symptoms and led to coronary angiography. Duygu et al. [5] found that that the age of MB patients with coronary atherosclerosis was significantly higher compared with patients without coronary atherosclerosis. We found similar age between those groups; however, diabetes was more prevalent in patients with significant coronary atherosclerosis. Interestingly, patients with significant atherosclerosis proximal to the bridge had significantly shorter bridge length compared to the patients without atherosclerosis, and there was no significant difference regarding systolic compression rates. The cause of this observation is not clear and suggests that the tendency for increased atherosclerosis at the proximal segment is not solely related to hemodynamic factors associated with the bridge.

Presentation with the acute coronary syndrome was more prevalent in MB patients with significant atherosclerosis in any of the arteries compared to patients with isolated MB. It seems that atherosclerotic lesions may be more prone to cause acute coronary syndrome than the bridge itself. We could not demonstrate any differences regarding demographic and angiographic variables in isolated MB patients who presented with the acute coronary syndrome. The length of the bridge was longer, but the significance failed to reach statistical significance. It seems that patients with a longer bridge may have a tendency for developing acute coronary syndrome in accordance with the hypothesis that trauma and damage to the endothelium may predispose patients to the development of the acute coronary syndrome.

Conclusion

The prevalence of MB was 1.07% in our study, which is consistent with the angiographic prevalence rates that have been reported by similar studies from our country. We could not find a consistent relationship between the angiographic characteristics of MB and the development of atherosclerosis or acute coronary syndrome. It may be suggested that coexisting atherosclerotic lesions may be more closely related to ischemic symptoms and the development of acute coronary syndrome that necessitated coronary angiography in our study.

Ethics Committee Approval: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: A.K., B.M.; Design: A.K., A.P.; Data Collection or Processing: A.K., A.P.; Analysis or Interpretation: A.K., A.P., B.M., O.Y.; Literature Search: A.K., A.P.; Writing: A.K., A.P.

Conflict of Interest: None declared.

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