Original Article

Concurrent Myocardial Bridging and Coronary Artery Disease: A Study of an Iranian Population

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Abstract

Background: *Myocardial bridging (MB) has been associated with acute coronary syndrome, ischemia, arrhythmia, and even sudden death. This study investigated the prevalence of MB and its complications and manifestations.*

Methods: *This cross-sectional study was conducted on symptomatic coronary patients who underwent angiography between March 2022 and March 2023 at Afshar or Shahid Sadoughi hospitals in Yazd, Iran. The angiographic reports of all patients were evaluated. Cases with MB were selected, and their angiographic films were assessed by an interventional cardiologist for diagnostic accuracy. Baseline, radiological, and clinical characteristics were also evaluated. Data were collected and analyzed using SPSS, version 20.0. The dependent variable was stratified based on independent variables using the χ^2 test.*

Results: *Out of 3750 symptomatic patients, 165 (4.4%) were diagnosed with MB. Among these, 111 (67.3%) were male, and the mean age was 56.87±10.06 years. A total of 152 patients had MB in the left anterior descending artery, representing the highest occurrence proportion at 92.1%. The most common types of coronary artery disease (CAD) diagnosed included mono-vessel disease and slow flow, accounting for 35.1% and 25.8%, respectively. There was no significant frequency distribution of CAD co-occurrence based on baseline and radiological features (P>0.050).*

Conclusion: *This study provides valuable insights into the prevalence of MB in Iran and its co-occurrence with CAD. While some findings align with previous research, certain discrepancies warrant further investigation.*

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Keywords: *Myocardial bridging; Acute coronary syndrome; Angiography*

Introduction

Myocardial bridging (MB) is a congenital coronary anomaly[1] characterized by myocardium covering segments of coronary arteries.[2] MB refers to the muscle overlying the artery, while the artery itself is called the "tunneled artery." MB most frequently affects the middle portion of the left coronary artery but can rarely occur in the right coronary artery or both. The condition was first discovered by physician Henric Reyman during an autopsy in 1732.

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MB can lead to compression of the coronary artery during systole, resulting in reduced blood flow to the myocardium.[3] Consequently, MB may cause various clinical symptoms, ranging from angina and ischemia to syncope with arrhythmia and heart failure, or even sudden death.[3] Nonetheless, in most patients, the condition is benign and is only incidentally discovered during autopsy.[2] Notably, MB is highly prevalent among patients with hypertrophic cardiomyopathy.[4]

Although this congenital malformation is present at birth, diagnosis typically occurs during the third decade of life. Furthermore, acute MB has been identified as a significant risk factor for myocardial infarction with nonobstructive coronary arteries (MINOCA).[5] In addition, a case report documented the presence of left anterior descending (LAD) MB in a sudden death incident.[6]

The prevalence of MB has been investigated in numerous studies, with varying results. A meta-analysis conducted by Hostiuc et al[7] revealed an overall MB prevalence of 19%; autopsy studies showed a 42% prevalence, computed tomography angiography studies demonstrated 22%, and coronary angiography indicated 6%. The authors also reported that in the majority of cases, bridges were found in the LAD.

Albeit limited, some studies have investigated the prevalence of MB in Iran. One such study conducted at Tabriz University of Medical Sciences examined 534 patients with symptoms suggestive of CAD and reported a 6.0% prevalence of MB in symptomatic patients.[8]

The significance of MB has been steadily rising, particularly in patients with acute coronary syndrome or aborted sudden cardiac death. Early identification and monitoring of individuals with MB could enable effective preventative measures, which would be crucial for diagnosing arrhythmias and atrioventricular conduction block and reducing the risk of sudden cardiac death.

In light of these potential benefits, this study aimed to evaluate the prevalence and clinical characteristics of patients diagnosed with myocardial bridging.

Methods

This cross-sectional study enrolled symptomatic patients who underwent angiography between March 2022 and March 2023 at Afshar and Shahid Sadoughi hospitals in Yazd, Iran. Patients with a history of coronary artery bypass graft surgery were excluded from participation. The study adhered to the Declaration of Helsinki's ethical principles and received approval from the Ethics Committee of Shahid Sadoughi University of Medical Sciences (IR.SSU.MEDICINE.REC.1401.123). Informed consent was obtained from all participants, and participation in the study was voluntary.

Baseline characteristics, such as age, sex, smoking status, and medication use, were assessed, along with clinical characteristics like underlying diseases and history of CAD. Moreover, the presence of coronary MB, coronary artery stenosis (defined as >50% diameter narrowing in the coronary vessel), and left ventricular ejection fraction (LVEF) based on echocardiography were evaluated as radiological characteristics.[9]

CAD comprises various conditions that disrupt the normal functioning of coronary arteries. This category includes coronary slow flow, mild CAD (characterized by mild atherosclerotic plaque formation or nonobstructive coronary artery stenosis), significant CAD (mono-vessel disease [MVD], 2-vessel disease [2VD], or 3-vessel disease [3VD]), coronary artery ectasia (abnormal vessel dilation), and MINOCA.

In this study, the specific artery affected by MB was considered. Significant CAD was characterized by atherosclerotic narrowing exceeding 50% of the vessel lumen in 1, 2, or 3 vessels. LVEF was classified into 4 categories: normal (≥55%), preserved (50%–54%), mild to moderate (35%–49%), and severe (<35%).[10]

MB was categorized as deep (>2 mm) or superficial (<2 mm). The diagnosis of MB was established by reviewing coronary angiograms, with confirmation by 2 interventional cardiologists. Both deep and curved superficial cases of MB were included in the present study.[11]

Data collection and analysis were performed using the Statistical Package for Social Sciences (SPSS), version 20.0. Quantitative variables were presented as mean ± standard deviation, while independent qualitative variables were represented as counts (percentages). The χ^2 test was the sole statistical analysis method employed. A P value of less than 0.05 was considered statistically significant.

Results

A total of 3750 coronary angiograms were screened, and angiographic data revealed an MB prevalence of 4.4% (165 patients) (Table 1). Among these patients, 111 (67.3%) were male, resulting in a male-to-female ratio of 2.06:1. The mean age of patients was 56.87±10.06 years, with the highest proportion of patients falling within the 55–64 age range (41.2%). The LAD was identified as the most frequently involved coronary artery, with 152 patients (92.1%) demonstrating MB in this region.

Hypertension was the most common underlying condition, present in 103 patients (62.4%), with more than half of them (58.8%) also diagnosed with CAD. The majority of CAD diagnoses were attributed to MVD and coronary slow flow (35.1% and 25.8%, respectively). Smoking and addiction were observed in 27.9% and 19.4% of patients, respectively (Table 1).

The co-occurrence of CAD was higher in men (63.1%) than in women (36.9%), although this difference was not statistically significant (*P*=0.110). Similarly, age categories did not show a significant distribution based on CAD co-occurrence (*P*=0.381). LVEF was categorized into 4 subgroups, and no statistically significant relationship with CAD co-occurrence was observed (*P*=0.333).

Table 1. Baseline characteristics and radiological features of the study population

Characteristic	Frequency
Age (y)	
1-44	20 (12.1)
45-54	47 (28.5)
55-64	38 (41.2)
65 and more	30 (18.2)
Sex	
Male	111 (67.3)
Female	54 (32.7)
Involved coronary artery	
LAD	152 (92.1)
LCX	7 (4.2)
RCA	0 (0)
LAD, LCX	6 (3.6)
Background disease	
Diabetes	51 (30.9)
Hypertension	103 (62.4)
Heart failure	92 (55.8)
Smoker	46 (27.9)
Drug history	32 (19.4)
CAD co-occurrence	97 (58.8)
Coronary slow flow	25 (25.8)
Mild CAD	14 (14.4)
MVD	34 (35.1)
2VD	14 (14.4)
3VD	6 (6.2)
Coronary artery ectasia	3 (3.1)
MINOCA	1 (1.0)
LVEF	
Severe reduction (<35%)	4 (2.5)
Mild-to-moderate reduction (35%–49%)	25 (15.2)
Preserved (50%–54%)	63 (38.1)
Normal (55%–60%)	73 (44.2)

LAD, Left anterior descending; LCX, Left circumflex; RCA, Right coronary artery; CAD, Coronary artery disease; EF, Ejection fraction; MVD, Mono-vessel disease; 2VD, 2-Vessel disease; 3VD, 3-Vessel disease; MINOCA, Myocardial infarction with nonobstructive coronary arteries; LVEF, Left ventricular ejection fraction

In patients with underlying conditions such as diabetes mellitus (*P*=0.737), hypertension (*P*=0.424), and hyperlipidemia (*P*=0.383), MB appeared to coexist with CAD more frequently. Nevertheless, these associations were not statistically significant (Table 2).

Table 2. Baseline and radiological characteristics of MB patients stratified by CAD co-occurrence.

Characteristic	MB (n=68)	MB + CAD (n=97)	P
Sex			0.110
Male	41 (36.9)	70 (63.1)	
Female	27 (50.0)	27 (50.0)	
Age (y)			0.381
1-44	8 (40.0)	12 (60.0)	
45-54	23 (48.9)	24 (51.1)	
55-64	23 (33.8)	45 (66.2)	
65 and more	14 (46.7)	16 (53.3)	
LVEF			0.333
Severe reduction (< 35%)	1 (25.0)	3 (75.0)	
Mild-to-moderate reduction (35% - 49%)	0 (00.0)	3 (100.0)	
Preserved (50%–54%)	9 (34.6)	17 (65.4)	
Normal (55%–60%)	58 (43.9)	74 (56.1)	
Diabetes mellitus	29 (56.9)	22 (43.1)	0.737
Hypertension	40 (38.8)	63 (61.2)	0.424
Heart failure	33 (35.9)	59 (64.1)	0.118
Hyperlipidemia	21 (46.7)	24 (53.3)	0.383
History of ischemic heart disease	14 (34.1)	27 (65.9)	0.289
Smoking	17 (37.0)	29 (63.0)	0.490
Addiction	15 (46.9)	17 (53.1)	0.469

MB, Myocardial bridge; LVEF, Left ventricular ejection fraction; CAD, Coronary artery disease

Discussion

MB is a congenital anomaly characterized by a tunneled segment of a major coronary artery passing through the myocardium.[12] Although initially considered clinically insignificant, subsequent studies have shown that MB can be associated with myocardial ischemia and sudden cardiac death.[13] In most instances, MB is discovered incidentally during coronary angiography.[14]

The primary objective of the current study was to examine the prevalence of MB in a specific population and its co-occurrence with CAD and other known atherosclerotic risk factors.

The prevalence of MB is known to be influenced by the diagnostic methods employed. In this study, the prevalence of MB among 3750 cases was determined to be 4.4% using coronary angiography. A review of previous studies from the last 2 decades indicates a similar prevalence in various regions. For instance, Erdem et al[15] examined a population of 6237 patients and reported an MB prevalence of 3.1%. In addition, a study by Shabestari et al[14] in Iran in 2012 reported a total MB prevalence of 21.3%. However, a direct comparison with the present study is not feasible, as Arjmand and colleagues considered both deep and superficial MB

cases, whereas this study focused solely on specific MB anomalies. On the other hand, the results align with those of a study conducted in rural areas of western India from 2013 through 2018, which detected an MB prevalence of 4.77% based on angiographic data. Furthermore, a study by Takamura et al[16] at Toho University Omori Medical Center in Japan reported a prevalence of MB in patients with MI at 18.9%. Another study conducted in Tabriz, Iran, investigated the prevalence of MB in symptomatic patients, reporting a rate of 6.0%, which was slightly higher than the rates in some other studies.[8]

The mean age of patients diagnosed with MB in this study was 56.87±10.06 years, which is similar to the findings of other studies. For instance, Darabian et al[17] reported a mean age of 52.60±12.70 years in their study conducted in Iran from 2004 through 2005. Nonetheless, the sex distribution in the current study was 67.3% male, which differs from the 94.7% male distribution reported by Darabian and colleagues. This discrepancy may be attributed to the small sample size of patients diagnosed with MB in their study. Additionally, a study conducted by Shakya et al[18] in Nepal from 2018 through 2021 reported a mean age of 54.52±10.31 years for patients diagnosed with MB. In their study, male patients comprised 68.9% of the diagnosed population, similar to the findings of the present study.

The LAD was found to be the most commonly involved coronary artery in MB cases (92.1%). This finding is consistent with other studies, such as a 2021 published article demonstrating a 1.42% prevalence of MB in the LAD among patients referred for coronary angiography between 2012 and 2020.[19] Similarly, an Indian cross-sectional study reported a 61% prevalence,[14] while studies by Çiçek et al[20] and Darabont et al[21] found rates of 77.2% and 98.7%, respectively. These results align with data collected from an Iranian population by Javad Rashid et al,[8] suggesting a high prevalence of LAD involvement in MB cases across different populations.

The present study indicated a higher prevalence of MB in the male population (67.3%). This finding chimes with other studies, such as those conducted by Asokan et al,[22] who reported an MB prevalence of 66.40% in males, Matta et al,[19] who found a 70% prevalence in males, and Shabestari et al,[14] who reported a 65% prevalence in males in Iran.

Our study estimated the prevalence of CAD co-occurrence at 58.8%. Notably, few studies have directly compared isolated MB with MB in the presence of CAD. A study by Nam et al[23] compared the baseline characteristics of isolated MB and MB co-occurring with coronary artery stenosis, a subtype of CAD. While there was a substantial difference in the male population between these 2 groups, no statistically significant association was found. Other characteristics, such as age, high blood pressure, and LVEF, were similar between the groups and showed no significant differences.

Historically, MB was thought to result in a negligible reduction of up to 15% in blood flow. Nevertheless, recent studies have suggested a potential correlation with clinically evident MI. Rinaldi et al[24] discussed various mechanisms that could contribute to the underlying etiology of MINOCA. In the present study, the concomitance rate of MINOCA with MB was reported to be 1.0%. These findings raise questions about the possible association between MB and MINOCA, emphasizing the need for future studies.

Significantly, a meta-analysis conducted by Hostiuc et al[25] found no significant increased risk of MI in the presence of MB. Surprisingly, the study indicated a reduced likelihood of MI when both MB and CAD were present. These findings underscore the need for further research to better understand the complex relationship between MB and CAD.

The presence of MB may lead to plaque formation and an increased likelihood of atherosclerosis due to altered blood pressure and near-wall blood flow proximal to the MB.[26] In light of this, Matta et al[19] conducted a study examining the prevalence of MB in the LAD and its potential association with coronary artery atherosclerosis. The results demonstrated significant angiographic atherosclerosis in 46.7% of the overall population and in 22.4% of those with MB in the LAD. Still, further statistical analyses revealed no significant relationship between MB and underlying conditions such as diabetes mellitus and hypertension. While the study by Matta and colleagues revealed similar findings regarding the absence of a significant relationship between MB and hypertension, it also discovered a significant association between MB and diabetes. A recent retrospective long-term study conducted by Bárczi et al[27] found that patients with LAD-MB and significant atherosclerotic lesions had a significantly higher prevalence of diabetes mellitus and other underlying conditions, such as hypertension, compared with patients with isolated LAD-MB. However, the observed differences may be attributable to the significant age differences between the 2 groups. Aging is known to increase the risk of both atherosclerosis and diabetes, so the disparities in health conditions could be a consequence of this demographic factor.

Our study has several limitations, including the lack of evaluation and estimation of body mass index, financial situation, occupation, and lifestyle. Although we considered data from symptomatic patients admitted for angiography, the clinical presentations of MB patients were not taken into account.

Conclusion

This study offers valuable insights into the prevalence of MB in Iran and its co-occurrence with CAD. While some findings were consistent with previous research, certain discrepancies merit further investigation. Additional research is needed to fully understand the pathophysiological

mechanisms and clinical symptoms of this anatomical anomaly.

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