



# Epidemiological, Angiographic and Cardiovascular Outcomes of Patients Diagnosed with Myocardial Bridge

Reza Pourbahador<sup>1</sup>, Mostafa Kohi<sup>1</sup>, Tolou Hasandokht<sup>1</sup>, Zahra Ahmadnia<sup>1</sup>, Arsalan Salari<sup>1,\*</sup>

<sup>1</sup> Department of Cardiology, Cardiovascular Diseases Research Center, Heshmat Hospital, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran

\*Corresponding author: Cardiovascular Diseases Research Center, Department of Cardiology, Heshmat Hospital, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran. Email: asalari828@gmail.com

Received 2024 January 31; Revised 2024 April 5; Accepted 2024 May 7.

## Abstract

**Background:** Myocardial bridging (MB) is a congenital coronary anomaly that can lead to harmful cardiac consequences if not diagnosed and treated.

**Objectives:** This study aims to evaluate the Epidemiological, angiographic, and cardiovascular outcomes of patients diagnosed with myocardial bridge.

**Methods:** The current research was conducted as a retrospective study in which 151 patients who underwent angiography participated. These patients were admitted between May 2014 and May 2016 at Heshmat and Aria hospitals in Rasht. The collected information in the present study included age, gender, blood pressure history, diabetes mellitus, blood lipid disorders, ischemic changes in ECG, ischemic changes in heart scan, output fraction, ischemic changes in exercise test, number of bridges, name of vessel, length of muscle bridge, and distance from the opening. To analyze the variables, the Chi-square test and independent *t*-test were used.

**Results:** As a result, we found that myocardial bridging was present in 57 patients, and 95.08% of the bridges were located above LAD. According to this study, there is no significant relationship between the length of the bridge and the distance of the bridge from the vessel opening with the occurrence of ischemic changes in ECG and myocardial perfusion scan ( $P > 0.05$ ). However, the average distance of the bridge from the vessel opening in patients who had a positive exercise test was lower compared to the patients who had a negative test. They had a negative exercise test, and this difference was statistically significant ( $P < 0.05$ ).

**Conclusions:** Furthermore, in patients diagnosed with an MB by CAG, the most MB located in the LAD, and this issue can help to better understand the outcome and how to manage these patients.

**Keywords:** Myocardial Bridging, Coronary Artery Disease, Atherosclerosis, Myocardial Infarction, Angiography

## 1. Background

Myocardial bridging (MB) is the most common type of congenital abnormality that usually exhibits no specific symptoms, but it can lead to dangerous disorders in the human heart. According to the obtained results, diagnosing this disease is very difficult because most of the time it presents no symptoms, or complications are rare (1-4).

In MB, a portion of the coronary arteries delves into the underlying layer of the heart muscle and then emerges again. Typically, in 70 - 90% of cases, the myocardial bridge is located in the second part of the left anterior descending artery (LAD) (3-6).

In advanced stages of this disease, when the cardiac muscle bridge enlarges and exerts pressure on the coronary arteries supplying the heart, individuals may experience symptoms such as angina pectoris, myocardial ischemia, acute coronary syndrome, left ventricular dysfunction, arrhythmias, and even sudden cardiac death (1, 5-8). Myocardial bridging should be considered a possible cause of exertional chest pain, especially in young patients with no significant coronary artery disease. Physiological assessment to confirm the hemodynamic significance of MB involves exercise echocardiography or dobutamine myocardial perfusion imaging (6).

Moreover, coronary angiography is considered the gold standard for diagnosing this disorder. Other modalities, like intravascular sonography and multidetector computed tomography, are also useful for diagnosis (9, 10). During coronary angiography, the detection rate of MB is relatively low, ranging from 0.8% to 4.9% (6). The diagnosis of MB by coronary angiography is challenging as it relies on indirect signs, including “systolic compression and the milking effect,” rather than direct visualization. Thus, studies that used coronary angiography underestimated the prevalence of MB compared to pathological studies. However, it has been noted that more MB were detected in studies where the investigator was exploring previous angiographies to search for MB (11), or when intracoronary acetylcholine was used (9, 11). Although the prevalence of MB varies significantly according to the methods used and the conditions of the patients, studies show that among patients with hypertrophic cardiomyopathy, the phenomenon of MB is significantly more frequent, with an average prevalence of 30% in adults (9, 12).

## 2. Objectives

Given the significant diversity in the form and clinical manifestations observed in patients with myocardial bridge, a patient registry and survey are necessary to better understand the outcomes and determine the best management methods for these patients. Thus, this study aimed to assess the epidemiological, angiographic, and cardiovascular outcomes of patients diagnosed with myocardial bridge.

## 3. Methods

This two-centered, cross-sectional prospective study was conducted at a tertiary center in the North of Iran, enrolling 151 consecutive patients who had undergone angiography at Heshmat and Aria hospitals in Rasht from May 2014 to May 2016. Ninety-four patients did not meet the inclusion criteria and were excluded from the study.

(1) Patients undergoing coronary angiography or coronary artery bypass graft (CABG).

(2) Patients who, in addition to myocardial bridge, have another vascular stenosis that may cause cardiac ischemic symptoms (any stenosis of more than 70% in the angiography report).

### 3.1. Statistical Method

All data were entered into SPSS version 16 software, and quantitative variables were reported as mean and standard deviation, while qualitative variables were reported as frequency percentages. Descriptive statistics, chi-square tests, and independent *t*-tests were used for analyzing the data, and the significance level for the tests was set at  $P < 0.05$ .

## 4. Results

Table 1 presents the demographic and clinical information of the participants. Among the 57 patients examined in this study, 53 patients (93%) had a single bridge, and 4 patients (7%) had two bridges. All patients with a single bridge in this study had left anterior descending artery (LAD) involvement, while 4 patients had two bridges, 3 patients had another vessel involved in addition to LAD, and one patient had two bridges on LAD. Among the total of 61 bridges observed in 57 patients, LAD was the most commonly involved vessel, with 58 (95.08%) bridges located above LAD. The other 3 bridges were located above the RCA, OM, and Diagonal.

Table 2 demonstrates the frequency of myocardial bridge based on clinical and paraclinical findings. Of patients with a single myocardial bridge, 27.1% had positive ischemic changes in ECG, 69.6% had ischemia in the exercise test, 76.1% had hypertension, 41.3% had diabetes, and 78.1% had hyperlipidemia.

According to Table 3, the average bridge length in patients with positive ischemic changes in ECG was  $17.3 \pm 6.6$  mm, with a positive exercise test was  $14.89 \pm 1.49$  mm, and in patients with a positive heart scan was  $16.78 \pm 7.52$  cm. Using independent *t*-test analysis, there was no significant difference in terms of myocardial bridge length with paraclinical findings ( $P > 0.05$ ). Additionally, the average distance between the myocardial bridge and the vessel in patients with positive ischemic changes in ECG was  $48.08 \pm 6.68$ , with a positive exercise test was  $44.919 \pm 9.97$ , and in patients with a positive heart scan was  $50.55 \pm 11.17$ . Using statistical tests, there is a significant difference between the two groups with positive and negative exercise test in terms of the distance between the bridge and the opening of the vessel ( $P = 0.010$ ), while according to the rest of the paraclinical findings, there was no statistically significant difference in the distance from the bridge to the vessel opening ( $P > 0.05$ ).

Characteristics of one myocardial bridge based on gender are demonstrated in Table 4. According to this table, the average length of the vein bridge is  $18.05 \pm 6.8$  in men and  $13.44 \pm 2.8$  in women, and using independent *t*-test analysis, there is a significant difference between the two genders in terms of the

**Table 1.** Demographic and Clinical Information of the Participants

Variables	Values <sup>a</sup>
Age (y)	56.12 ± 9.8
<b>Sex</b>	
Male	33 (57.9)
Female	24 (42.1)
<b>Number of bridge</b>	
Single bridge	53 (93)
Two bridges	4 (7)
<b>Involvement of a vessel with a bridge</b>	
LAD	53 (93)
<b>Involvement of a vessel with two bridges</b>	
LAD	1 (1)
LAD and another vessel	3 (6)
<b>HIP</b>	
Yes	36 (63.15)
No	21 (36.85)
<b>HTN</b>	
Yes	35 (61.4)
No	22 (38.6)
<b>DM</b>	
Yes	19 (33.3)
No	38 (66.7)

Abbreviations: HIP, hyperlipidemia; DM, diabetes mellitus; HTN, hypertension.

<sup>a</sup> Values are expressed as mean ± SD.

length of the bridge (P-value = 0.004). The average distance between the myocardial bridge and the vessel is  $54.24 \pm 15.57$  and  $43.67 \pm 7.81$  in men and women, respectively. Additionally, using independent *t*-test analysis, it was realized that there is a significant difference between the two sexes in terms of the length of the pons (P-value = 0.004).

## 5. Discussion

This study investigated the characteristics of muscle bridges and the severity of myocardial ischemia in patients undergoing angiography. Among the 57 patients examined, most with myocardial bridges were men, with men outnumbering women by about 1.5 times. Previous studies have also shown a higher prevalence of myocardial bridges in men compared to women, although the exact ratio varies widely across studies (9, 13, 14).

Our data revealed that 95.08% of bridges were located above the LAD, while the remaining bridges were situated above the RCA, OM, and Diagonal artery. Researchers suggest that the prevalence of bridges mainly on the LAD is due to its straight longitudinal path, whereas both the RCA and the Circumflex arteries

have more curved paths. Consequently, this anomaly is more easily visible and detectable in angiography, whereas bridges located on other arteries may be less conspicuous and more likely to go unnoticed, often only detected during autopsy.

Contrary to previous findings (15), a minority of patients in our study exhibited ischemic changes in the ECG. Additionally, most patients had hyperlipidemia and hypertension, while diabetes was present in less than half of the patients. It's worth noting that among these comorbidities, hypertension is more strongly associated with myocardial bridges, potentially leading to increased myocardial thickness. Consequently, this complication is more commonly observed in patients with hypertrophic cardiomyopathy. Greater myocardial thickness is associated with more effective bridges and increased ischemic events, leading to more positive paraclinical findings, such as ECG abnormalities, positive exercise tests, and abnormal heart scans in these patients.

The observed differences may also be influenced by racial and epidemiological disparities across different societies, as well as variations in healthcare systems among different countries.

**Table 2.** Frequency of Myocardial Bridge Based on Clinical and Paraclinical Findings<sup>a</sup>

Variables	One Myocardial Bridge (n = 53)	Two Myocardial Bridges (n = 4)
<b>HIP</b>		
Yes	36 (78.1)	3 (75)
No	10 (21.7)	1 (25)
<b>DM</b>		
Yes	19 (41.3)	1 (25)
No	27 (58.7)	3 (75)
<b>HTN</b>		
Yes	35 (76.1)	3 (75)
No	11 (23.9)	1 (25)
<b>ECG</b>		
Positive	13 (27.1)	1 (25)
Negative	35 (72.9)	3 (75)
<b>ETT</b>		
Positive	16 (69.6)	-
Negative	7 (30.4)	4 (100)
<b>Heart scan</b>		
Positive	21 (84)	1 (25)
Negative	4 (16)	3 (75)

Abbreviations: ECG, electrocardiography; ETT, exercise tolerance test; HIP, hyperlipidemia; DM, diabetes mellitus; HTN, hypertension.

<sup>a</sup> Values are expressed as No. (%).**Table 3.** Examination of One Myocardial Bridge Based on Paraclinical Findings<sup>a</sup>

Variables	ECG		P-Value <sup>b</sup>	ETT		P-Value <sup>b</sup>	Heart Scan		P-Value <sup>b</sup>
	Positive	Negative		Positive	Negative		Positive	Negative	
Myocardial bridge length	17.3 ± 6.6	15.6 ± 0.98	0.4	14.89 ± 1.49	17.4 ± 2.35	0.372	16.78 ± 7.52	15.5 ± 4.5	0.74
The distance between the myocardial bridge and the vessel	48.08 ± 6.68	50.56 ± 29	0.599	44.919 ± 9.97	63.214 ± 21.52	0.01	50.55 ± 11.17	47.92 ± 26.39	0.736

Abbreviations: ECG, electrocardiography; ETT, exercise tolerance test.

<sup>a</sup> Values are expressed as mean ± SD.<sup>b</sup> Independent t-test (P < 0.05 significance level).

In terms of the average length of the myocardial bridge and the average distance from the bridge to the vessel orifice, we observed higher values in males compared to females. A study by Radu et al. on myocardial bridges indicated a difference of 9.9 mm between the maximum length of myocardial bridges in the two genders, with an average length difference of 4.22 mm, both favoring males (16).

The results of our study showed that the average length of the myocardial bridge and the average distance from the bridge to the vessel orifice were greater in men than in women. However, we found no significant relationship between the length of the bridge and the occurrence of ischemic changes in ECG,

exercise tests, and myocardial perfusion scans. Controversy exists regarding the correlation between ischemic symptoms and the length of the tunneled segment (17).

Nevertheless, a significant relationship was observed between the distance of the bridge from the opening of the vessel and ischemic changes in the exercise test. The average distance of the bridge from the vessel opening was shorter in patients with a positive exercise test compared to those with a negative test (P-value = 0.010). These new findings suggest that exercise stress tests often reveal nonspecific signs of ischemia, conduction disturbances, or arrhythmias, making it challenging to distinguish between MB and other causes of myocardial

**Table 4.** Characteristics of One Myocardial Bridge Based on Gender <sup>a</sup>

Variables	Total	Men	Women	P-Value <sup>b</sup>
Myocardial bridge length	16.051 ± 5.87	18.05 ± 6.8	13.44±2.8	0.004
The distance between the myocardial bridge and the vessel	49.655 ± 13.75	54.24 ± 15.57	43.67±7.81	0.004

<sup>a</sup> Values are expressed as mean ± SD.<sup>b</sup> Independent *t*-test (*P* < 0.05 significance level).

ischemia. Angina frequently occurs during exercise, even in the absence of ECG changes (14).

Researchers suggest that including more patients in the study or utilizing another diagnostic modality such as CT angiography could provide further insights into myocardial bridges. They recommend investigating the myocardial depth of the bridges in addition to their length and distance from the vessel opening, along with exploring the relationship between bridge depth and myocardial ischemia. Additionally, they propose modifying the assessment of the bridge length by considering the ratio of the bridge length to the total length of the involved vessel. Regarding the distance of the bridge from the orifice, it is suggested to evaluate not only the longitudinal distance in millimeters but also the position of the bridge within the LAD, determining whether it is located in the proximal, mid, or distal portion of the vessel. Since the severity of myocardial bridge compression may vary over time, leading to variations in ischemia examination results such as exercise tests, heart scans, and ECGs, the researchers recommend prospective examination of the consequences and diagnostic modalities.

### 5.1. Conclusions

In patients diagnosed with an MB by coronary angiogram (CAG), the highest occurrence of MB was found in the LAD. This finding may contribute to a better understanding of outcomes and guide the selection of optimal management methods for these patients.

### Acknowledgements

The present research project received approval from the Vice Chancellor of Research of Guilan University of Medical Sciences, which provided financial support for the study. The authors express their gratitude to the staff of Heshmat Hospital, especially those involved in the research, for their sincere cooperation.

### Footnotes

**Authors' Contribution:** R.P. contributed to the study conception and design (lead), acquisition of data, and drafting the manuscript (lead). T.H. conducted the analysis and interpretation of data and statistical analysis. A.S. and Z.A. drafted the manuscript (supporting) and provided administrative support. M.K. assisted in the development of the study concept and design (supporting) and supervision. All authors read and approved the final manuscript.

**Conflict of Interests Statement:** The authors stated that they have no conflicts of interest.

**Data Availability:** The corresponding author will provide the data upon request.

**Ethical Approval:** The study protocol received approval from the scientific vice chancellor for research and the ethics committee of Guilan University of Medical Sciences (IR.GUMS.REC.1395.229.) and adhered to the ethical guidelines of the 1975 Declaration of Helsinki.

**Funding/Support:** The authors did not receive any support from any organization for the submitted work.

**Informed Consent:** All participants provided informed consent before inclusion in the study.

### References

1. Lee MS, Chen C. Myocardial bridging: an up-to-date review. *J The Invasive Cardiology*. 2015;**27**(11):521.
2. Adhikari S, Mainali A, Aryal B, Bista PB, Devkota S, Gousy N, et al. Myocardial bridging: two different clinical presentations in young males involving left anterior descending coronary artery. *J Cureus*. 2022;**14**(6). <https://doi.org/10.7759/cureus.26134>.
3. Happach VC, Delk GT, Ganti L. Myocardial Bridging, the Hidden Risk Factor for Ischemia. *Mil Med*. 2022;**187**(9-10):e1230-2. [PubMed ID: 33686440]. <https://doi.org/10.1093/milmed/usab042>.
4. Saito Y, Kitahara H, Shoji T, Tokimasa S, Nakayama T, Sugimoto K, et al. Relation between severity of myocardial bridge and vasospasm. *Int J Cardiol*. 2017;**248**:34-8. [PubMed ID: 28712560]. <https://doi.org/10.1016/j.ijcard.2017.07.002>.
5. Darabont RO, Visoiu IS, Magda SL, Stoicescu C, Vintila VD, Udroui C, et al. Implications of Myocardial Bridge on Coronary Atherosclerosis and Survival. *Diagnostics (Basel)*. 2022;**12**(4). [PubMed ID: 35453995]. [PubMed Central ID: PMC9026775]. <https://doi.org/10.3390/diagnostics12040948>.

6. Murtaza G, Mukherjee D, Gharacholou SM, Nanjundappa A, Lavie CJ, Khan AA, et al. An Updated Review on Myocardial Bridging. *Cardiovasc Revasc Med*. 2020;**21**(9):1169-79. [PubMed ID: 32173330]. <https://doi.org/10.1016/j.carrev.2020.02.014>.
7. Teragawa H, Oshita C, Ueda T. The Myocardial Bridge: Potential Influences on the Coronary Artery Vasculature. *Clin Med Insights Cardiol*. 2019;**13**:1179546819846490. [PubMed ID: 31068756]. [PubMed Central ID: PMC6495429]. <https://doi.org/10.1177/1179546819846493>.
8. Claudino Dos Santos JC, Barreto JEF, Fernando de Sousa Rodrigues C, Serra de Lima Junior FA, de Sa Braga Oliveira A. Morphological analysis of myocardial bridges and coronary arterial dominance in northeast Brazil. *Morphologie*. 2022;**106**(353):92-7. [PubMed ID: 33775545]. <https://doi.org/10.1016/j.morpho.2021.03.003>.
9. Sun JL, Huang WM, Guo JH, Li XY, Ma XL, Wang CY. Relationship between myocardial bridging and coronary arteriosclerosis. *Cell Biochem Biophys*. 2013;**65**(3):485-9. [PubMed ID: 23076634]. <https://doi.org/10.1007/s12013-012-9438-y>.
10. Karna SK, Chourasiya M, Parikh RP, Chaudhari T, Patel U. Prevalence of myocardial bridge in angiographic population-A study from rural part of western India. *J Family Med Prim Care*. 2020;**9**(4):1963-6. [PubMed ID: 32670948]. [PubMed Central ID: PMC7346928]. [https://doi.org/10.4103/jfmpc.jfmpc\\_1075\\_19](https://doi.org/10.4103/jfmpc.jfmpc_1075_19).
11. Gao W, Zhang J, Duan F, Guo S, Chen C, Du L, et al. Clinical characteristics and factors associated with coronary stenosis proximal to a myocardial bridge: a retrospective study. *BMC Cardiovasc Disord*. 2020;**20**(1):371. [PubMed ID: 32795253]. [PubMed Central ID: PMC7427715]. <https://doi.org/10.1186/s12872-020-01655-2>.
12. Gould KL, Johnson NP. Myocardial Bridges: Lessons in Clinical Coronary Pathophysiology. *JACC Cardiovasc Imaging*. 2015;**8**(6):705-9. [PubMed ID: 26068287]. <https://doi.org/10.1016/j.jcmg.2015.02.013>.
13. Zhao X, Fu Y, Li J, Sun M, Zhao H%. Impact of Myocardial Bridge-mural Coronary Artery on Myocardial Functions. *J Zhongguo yi xue ke xue Yuan xue bao. Acta Academiae Med Sinic*. 2016;**38**(6):654-9.
14. Rovai D, Di Bella G, Pingitore A, Coceani M. Myocardial bridging: a review with emphasis on electrocardiographic findings. *Ann Noninvasive Electrophysiol*. 2015;**20**(2):103-7. [PubMed ID: 25530097]. [PubMed Central ID: PMC6931837]. <https://doi.org/10.1111/anec.12242>.
15. Seo J, Park J, Oh J, Uhm JS, Sung JH, Kim JY, et al. High Prevalence and Clinical Implication of Myocardial Bridging in Patients with Early Repolarization. *Yonsei Med J*. 2017;**58**(1):67-74. [PubMed ID: 27873497]. [PubMed Central ID: PMC5122654]. <https://doi.org/10.3349/ymj.2017.58.1.67>.
16. Radu N, Petru B, Radu B, Viorel I. Morphological Features on Myocardial Bridges at the Anterior Interventricular Artery. *J ARS Medica Tomitana*. 2018;**24**(3):164-74. <https://doi.org/10.2478/arsm-2018-0030>.
17. Eftekhari-Vaghefi SH, Pourhoseini S, Movahedi M, Hooshmand S, Ostovan MA, Dehghani P, et al. Comparison of detection percentage and morphology of myocardial bridge between conventional coronary angiography and coronary CT angiography. *J Cardiovasc Thorac Res*. 2019;**11**(3):203-8. [PubMed ID: 31579460]. [PubMed Central ID: PMC6759614]. <https://doi.org/10.15171/jcvtr.2019.34>.