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Original Research Article

# ANGIOGRAPHIC ASPECTS OF MYOCARDIAL BRIDGES

**Sujatha. M *[1], V. Subhadra Devi [2], C. S. S. Raju [3], B. Yugandhar [4], Nagaraju [5].**

*[1] Ph.D. Scholar, Department of Anatomy, S.V.Medical College, Tirupati, Andrha Pradesh, India.

[2] Professor & Head, Department of Anatomy, SVIMS - Sri Padmavathi Medical College for women, Tirupati, Andrha Pradesh, India.

[3] Consultant Cardiologist, Sri Bollineni Super Speciality Hospital, Nellore, Andrha Pradesh, India.

[4] Consultant Cardiologist, Sri Venkata Sai Hrudayalaya, Tirupati Andrha Pradesh, India.

[5] Consultant Cardiologist, DBR & SK Hospital, Tirupati, Andrha Pradesh, India.

## ABSTRACT

**Introduction:** The segment of epicardial coronary artery that traverses intramurally through the myocardium and bridged by a bunch of cardiac muscle fibers is called tunneled artery or intramural artery. The band of cardiac muscle fibers passing over the tunneled artery segment is named as myocardial bridge. During angiography milking effect is observed during systole due to the external pressure of muscle fibers on the tunneled artery that leads to narrowing of vessel lumen and further ischemia.

**Materials & Methods:** It is a prospective study performed from 2012- 2015 in cardiac centers available around Tirupati, Andhra Pradesh, South India. A total number of 2015 adult patients who underwent diagnostic coronary angiography were evaluated to detect myocardial bridges. With the informed consent the relevant data was collected from the patients and analyzed.

**Results:** The prevalence of myocardial bridges was 3.17%. Among the 2015 patients 70.7% are males and 29.2% are females. Among 64 myocardial bridge positive cases 62.5% were male and 37.5% were female patients. Regarding coronary dominance 84% were right dominant and 14.4% were left dominant and 1.6% are balanced. The percentage incidence of myocardial bridging according to dominance was 3.01% for right dominant patients, 4.12% for left dominant patients and 3.1% for balanced dominant patients. In all the myocardial bridge positive cases they were located on the left anterior descending artery (LAD). According to diagnosis the patients with normal coronaries were 22.6%, patients with MILD CAD were 17.9%, patients with single vessel disease were 23.4%, patients with two vessel disease were 14.7% and the patients with triple vessel disease were 21.3%. The 64 myocardial bridging cases were grouped in to three groups according to their age. Incidence of double bridges was observed in 3 cases of which 66.7% males & 33.3% in females.

**Conclusion:** These results shows that Andhra Pradesh population are with high angiographic incidence of myocardial bridges (MB's), when compared with other population in India. We observed more lengthy bridges which may cause luminal reduction of coronary vessel and myocardial ischemia (MI), we also observed higher incidence of MB's in male patients but systolic luminal reduction is more in female patients then in males. These observations suggest that the risk of MI will be more for the female patients with MB's.

**KEY WORDS:** Angiogram, Myocardial bridge (MB), Milking effect, Left anterior descending (LAD).

**Address for Correspondence:** Mrs. Sujatha Manupati, Ph.D. Scholar, Department of Anatomy, Sri Venkateswara Medical College, Tirupati, Andhra Pradesh. India. Mobile No.: +919246943011
**E-Mail:** manupatisujatha@gmail.com

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## INTRODUCTION

Coronary arteries are normally epicardial in position except in some cases where a segment of coronary artery is overlapped by a bunch of cardiac muscle fibers. This pattern of arrangement of cardiac muscle fibers over a segment of coronary artery is known as myocar-dial bridging. The segment of coronary artery with intramural course is known as tunneled artery or intra mural artery. Myocardial bridging is recognized more than 250 years ago. Reyman (1737) observed MB at autopsy [1]. First myocardial bridge was reported in depth by Geiringer(1951) by anatomical dissection method [2]. The systolic compression of coronary artery by the myocardial bridge (MB) was first recognized angiographically by Portmann and Iwig in 1960 [3]. Recent studies during last century highlighted the clinical significance of myocardial bridges. The percentage incidence of myocardial bridges reported based on angiographic studies was 0.5-8.5% [4-6] and on observation during autopsy was 5.5 – 90% [7-13]. In the literature several controversial views were expressed on clinical significance of MB's. Some authors stated that myocardial bridges might have protective effect [14,15] on the coronary artery at the site of bridge. According to some authors there is relation between myocardial bridging and myocardial ischemia. Although myocardial bridges are asymptomatic in many patients its association with myocardial ischemia, stunting, heart failure, myocardial infarction and sudden cardiac death were reported [16,17].

Myocardial bridges are generally located on the middle segment of left anterior descending artery (LAD) involving different lengths of the coronary arteries and varying depths of myocardial wall. The main angiographic finding in myocardial bridging is systolic compression of epicardial coronary artery. Assessment of myocardial bridges is possible using several techniques including conventional angiography, intravascular sonography, intracoronary Doppler sonography and multi detector computed tomography (MDCT). Contraction of myocardial bridge causes compression of tunneled vessel leading to coronary obstruction. The percentage of coronary obstruction depends on various factors such as length of MB, thickness of MB and degree of cardiac contractility. The present study was carried out to find out the incidence of myocardial bridges in a large population of patients admitted for evaluation of chest pain in different cardiac centers around Tirupati, Andhra Pradesh, South India.

## MATERIALS AND METHODS

The present work was carried out with the permission of institutional ethical and research committee, S.V.Medical College, Tirupati, Andhra Pradesh, South India. It is a prospective study performed from 2012- 2015 in cardiac centers available around Tirupati, Andhra Pradesh, South India. A total number of 2015 adults who underwent diagnostic coronary angiography were evaluated for the presence of myocardial bridges. Relevant information was obtained from the patients with informed consent. All the patients underwent pre procedure care and angiogram (Judking technique) by using Philips H5000 Integris machine. All the coronary angiograms were observed for myocardial bridging. The MB was identified based on narrowing of coronary artery in systolic phase resulting in at least 50% reduction of luminal diameter in comparison with the diastolic phase. All the coronary angiograms were reviewed separately by two cardiologists and the cases were included if the luminal reduction is more than 50%.

Arteriographic quantification of systolic luminal compression was performed using a digital calipers (Mitutoyo digital calipers, model no. CD-6'' CSX) to measure the systolic luminal diameter, diastolic luminal diameter and length of myocardial bridge in systole. All the measurements were recorded in the left anterior oblique position. The percentage of luminal reduction was calculated by the following formula.

Luminal diameter reduction %: 100-[2m (D1+D2)×100 ] where

m: minimal luminal diameter in systole.

D1: diastolic diameter proximal to the obstruction.

D2: diastolic diameter distal to the obstruction.

**Statistical analysis**: The recorded data was subjected to statistical analysis by applying

following statistical tests using SPSS 20 software.

1. Chi-square test was applied to find out the significance of variable in bridging positive cases.
2. T- test was applied to find out the significance of length of MB's, minimum luminal diameter in systole, diameter proximal to MB, diameter distal to MB and % of luminal reduction with sex and dominance.
3. One way ANOVA was used for variable parameters of bridging positive cases with age of the patients.

## RESULTS

Among 2015 coronary angiograms obtained from patients of both sexes (1386 males and 565 females) MB's were observed in 64 (3.17%) patients with a sex-wise incidence of 2.9% among males (40/1386) and 4.2% among females (24/565) as shown in Table 1. Right coronary dominance was observed in 84% (1692/2015), left coronary dominance in 14.4% (291/2015) and balanced dominance in 1.6% (32/2015) of patients. The percentage incidence of myocardial bridging according to dominance was 3% (51/1692) for right dominant patients, 4.1% (12/291) for left dominant patients and 3.1% (1/32) for balanced dominant patients (Table 2). All the myocardial bridges were located on the left anterior descending artery (Figure 1&2). Out of 64 myocardial bridges 56 were located on middle segment of LAD (87.5%), 4 each on proximal (6.25%) and distal (6.25%) segments. According to clinical diagnosis (Table 3) 456 (22.6%) patients presented normal coronaries, 361 (17.9%) had mild CAD, 472 (23.4%) had single vessel disease (CADSVD), 297(14.7%) with two vessel disease (CAD2VD) and the remaining 429 (21.3%) had triple vessel disease (CAD2VD). Among the 64 bridged positive cases 22 (34.4%) were with normal coronaries, 23 (33.9%) were with mild CAD, 9 (14.1%) were with single vessel disease, 8 (12.5%) were with two vessel disease and 2 (3.1%) were with triple vessel disease. The 64 myocardial bridging cases were grouped according to age in to three groups ie. 20-40, 41-60 and above 60 years. The incidence of double bridges was observed in 03 cases. among 3 cases, 2(66.7%) cases were in males & 1(33.3%)case was in female (Table 4).

**Table 1:** Showing distribution of patients according to sex.

| | | Status | | Total |
|---|---|---|---|---|
| | | Negative | Positive | |
| SEX | Male | 1386 | 40 | 1426 |
| | | 71.00% | 62.50% | 70.80% |
| | Female | 565 | 24 | 589 |
| | | 29.00% | 37.50% | 29.20% |
| Total | | 1951 | 64 | 2015 |
| | | 100.00% | 100.00% | 100.00% |

**Table 2:** Showing distribution of patients according to dominance.

| | | Status | | Total |
|---|---|---|---|---|
| | | Negative | Positive | |
| DOMINANCE | Right | 1641 | 51 | 1692 |
| | | 84.10% | 79.70% | 84.00% |
| | Left | 279 | 12 | 291 |
| | | 14.30% | 18.80% | 14.40% |
| | Balanced | 31 | 1 | 32 |
| | | 1.60% | 1.60% | 1.60% |
| Total | | 1951 | 64 | 2015 |
| | | 100.00% | 100.00% | 100.00% |

**Table 3:** Showing distribution of patients according to diagnosis.

| | | Status | | Total |
|---|---|---|---|---|
| | | Negative | Positive | |
| DIAGNOSIS | NORMAL | 434 | 22 | 456 |
| | | 22.20% | 34.40% | 22.60% |
| | MILDCAD | 338 | 23 | 361 |
| | | 17.30% | 35.90% | 17.90% |
| | CADSVD | 463 | 9 | 472 |
| | | 23.70% | 14.10% | 23.40% |
| | CAD2VD | 289 | 8 | 297 |
| | | 14.80% | 12.50% | 14.70% |
| | CADTVD | 427 | 2 | 429 |
| | | 21.90% | 3.10% | 21.30% |
| Total | | 1951 | 64 | 2015 |
| | | 100.00% | 100.00% | 100.00% |

**Table 4:** Showing chi- squire test for sex and number of myocardial bridges.

| Chi-square value | p-value | NO.OF MYOCARDIAL BRIDGE | | Total |
|---|---|---|---|---|
| 0.023 | 0.879 | 1 | 2 | |
| SEX | Male | 38 | 2 | 40 |
| | | 62.30% | 66.70% | 62.50% |
| | Female | 23 | 1 | 24 |
| | | 37.70% | 33.30% | 37.50% |
| Total | | 61 | 3 | 64 |
| | | 100.00% | 100.00% | 100.00% |

The range of MB length was 3.13mm-53.72mm. Mean and standard deviations of length of myocardial bridges was 20.0525±12.613. Minimum luminal diameter of mural artery under the bridge in systole was 3.467±10.116, diameter of artery proximal to the myocardial bridge was 3.436± 0.99035, diameter of artery distal to myocardial bridge was 3.0125± 0.85112 and % of luminal reduction was 66.605±19.1164 (Table 5). The percentage of luminal reduction was in the range of 16.1%-91.7%. One way ANOVA, Chi-square and t- test was used to find out the significance of variable means in bridging positive cases but there is no significant difference between the variables.

## DISCUSSION

Myocardial bridges are a frequent finding during routine coronary angiogram. The incidence and pathophysiology of myocardial bridges remained controversial as there are several studies in the literature stating for and against the cardio-protective role of MB's in the last century. High incidence of MB's were reported at autopsy studies compared with angiographic studies [7-13].

**Fig. 1:** Showing diastole of LAD.

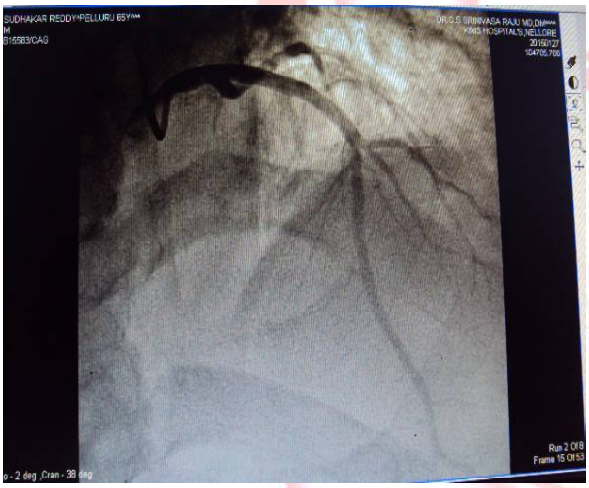

**Fig. 2:** showing systolic narrowing of LAD.

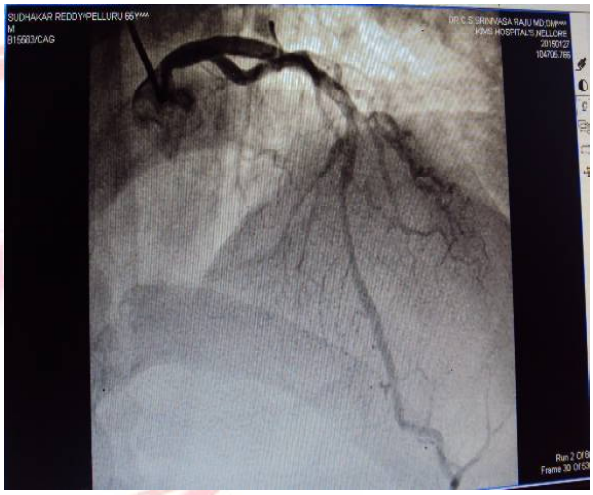

**Table 5:** Showing one- way ANOVA for parameters of bridging positive cases with age.

| | Age | Mean | Std. Deviation | Minimum | Maximum | F-value | p-value |
|---|---|---|---|---|---|---|---|
| LENGTH OF MB(mm) | 20 - 40 years | 13.505 | 5.64157 | 6.22 | 25.7 | 1.3 | 0.28 |
| | 41 - 60 years | 21.3295 | 12.88773 | 3.13 | 53.72 | | |
| | 60 and above years | 20.054 | 14.00858 | 4.12 | 46.02 | | |
| | Total | 20.0525 | 12.61375 | 3.13 | 53.72 | | |
| MIN LUMEN DIAMETER IN SYSTOLE (m) diameter in diastole | 20 - 40 years | 2.1688 | 0.43248 | 1.77 | 3.1 | 1.515 | 0.228 |
| | 41 - 60 years | 2.2768 | 0.66225 | 0.99 | 3.59 | | |
| | 60 and above years | 7.4133 | 20.91391 | 1.56 | 83 | | |
| | Total | 3.4672 | 10.11639 | 0.99 | 83 | | |
| DIAMETER PROXIMAL TO MB(d1) | 20 - 40 years | 3.1975 | 0.58265 | 2.38 | 3.99 | 2.248 | 0.114 |
| | 41 - 60 years | 3.6266 | 1.02817 | 1.74 | 6.73 | | |
| | 60 and above years | 3.0447 | 0.95943 | 1.88 | 5.22 | | |
| | Total | 3.4366 | 0.99035 | 1.74 | 6.73 | | |
| DIAMETER DISTAL TO MB(d2) | 20 - 40 years | 2.6363 | 0.52709 | 2.04 | 3.5 | 1.867 | 0.163 |
| | 41 - 60 years | 3.1598 | 0.86395 | 1.69 | 5.4 | | |
| | 60 and above years | 2.8107 | 0.89458 | 1.5 | 4.65 | | |
| | Total | 3.0125 | 0.85112 | 1.5 | 5.4 | | |
| % OF LUMINAL REDUCTION | 20 - 40 years | 74.133 | 8.9356 | 54.7 | 83.1 | 0.99 | 0.377 |
| | 41 - 60 years | 64.37 | 20.1462 | 16.1 | 89.4 | | |
| | 60 and above years | 68.697 | 19.8297 | 26.2 | 91.7 | | |
| | Total | 66.605 | 19.1164 | 16.1 | 91.7 | | |

**Table 6:** Angiographic incidence of myocardial bridges in the literature.

| Author | Year | Population | Sample Size | No.of MB | Percentage |
|---|---|---|---|---|---|
| L.Rossi et al [5] | 1980 | Italy | 1146 | 52 | 4.5 |
| Robert G et al [21] | 1982 | South carolina | 465 | 35 | 7.5 |
| Juilliere Y et al [4] | 1995 | - | 7467 | 61 | 0.82 |
| Harikrishnan et al [22] | 1999 | india | 3200 | 21 | 0.6 |
| Soran et al [23] | 2000 | turkey | 2547 | 26 | 1 |
| I.Lozano et al [24] | 2002 | murcia | 8333 | 60 | 0.72 |
| H.Teragawa et al [25] | 2003 | japan | 114 | 41 | 36 |
| Cay.s et al [26] | 2006 | turkey | 25982 | 316 | 1.22 |
| Ayfer mavi et al [27] | 2008 | turkey | 7200 | 29 | 0.4 |
| LI Jian et al [28] | 2008 | china | 37105 | 1002 | 2.7 |
| R.Javadrashid et al [29] | 2009 | iran | 534 | 32 | 6 |
| Qian Ju-ying et al [30] | 2009 | china | 5525 | 888 | 16.1 |
| Abhilash(31) | 2011 | Kerala, south india | 10492 | 129 | 1.23 |
| En- Senma et al [32] | 2013 | china | 2462 | 336 | 13.6 |

**Table 7:** Showing distribution of MB's number.

| Myocardial bridges | No. of patients | % of MB | No of bridges |
|---|---|---|---|
| Single MB | 61 | 95.3 | 61 |
| Double MB | 3 | 4.7 | 6 |
| TOTAL | 64 | 100 | 67 |

**Table 8:** Showing distribution of MB's on LAD.

| Segment of LAD | No of MB | % of MB |
|---|---|---|
| Proximal | 4 | 6.25 |
| Middle | 56 | 87.5 |
| Distal | 4 | 6.25 |

This may be due to the factors like length of myocardial bridge and the method that was used. The angiographic appearance of myocardial bridges depends on factors like thickness, length of myocardial bridge and arrangement of cardiac muscle fibers. Use of quality cine-angiographic equipment and best techniques with particular attention devoted to examining the phasic changes of coronary diameter might allow a higher number of myocardial bridges to be identified. Many authors reported angiographic studies on myocardial bridges in literature (Table 6). The most frequent site of MB reported in literature was on LAD, followed by left circumflex and right coronary artery [18-20]. We observed a total of 67 bridges in 64 patients. Single MB was observed in 61 patients (95.3%) and in 03 patients we observed double bridges (4.7%) (Table 7). In our study majority of myocardial bridges were located on the middle segment (87.5%) of LAD followed by distal (6.25%) and proximal (6.25%) segments of LAD (Table 8).

According to literature the percentage incidence of MB is more in Japanese (36%) followed by Chinese (16%) (Table 6). Harikrishnan et al. [22], Abhilash et.al. [31] and Swayam jothi et.al. [33] are the three authors who reported the percentage incidence of myocardial bridges in Indian population. Harikrishnan et al [22] reviewed 3200 patients and observed 21 (male-19, female-02) patients with myocardial bridges (0.6%). Abhilash et al [31] reviewed 10492 coronary angiograms and observed 129 patients with myocardial bridging (1.23%). Swayam jothi et al [33] studied 648 coronary angiograms and observed 4 patients with myocardial bridging (0.6%). The percentage incidence of 3.17% observed in the present study is higher than that reported in the literature in Indian population.

According to literature locational distribution of myocardial bridges were on left anterior descending artery followed by the left circumflex and the right coronary artery. Majority of myocardial bridges were reported on middle segment of LAD [27,28,31]. Ayfer Mavi et al [27] studied 7200 coronary angiograms in Turkey population and reported only 29 myocardial bridges and the percentage incidence was 0.4%. Among the 29 bridges 28 bridges were located on LAD (96.5%) and only 01 bridge was located on left circumflex artery (3.4%). Among those on LAD 22 (78.5%) bridges were located on the middle segment of LAD, 5 (17.8%) were on distal

segment of LAD and 01 (3.5%) was found extending on to both middle and distal segments.

LI Jion-Jun et al. [28], studied 37105 coronary angiograms in Chinese population and observed 1002 myocardial bridges with a percentage incidence of 2.70%. They observed myocardial bridges on LAD, left circumflex and right coronary artery. The distribution of myocardial bridges on LAD was 973 (97.1%), circumflex was 08 (0.79%) and on right coronary artery was 10 (.99%). The segmental distribution of myocardial bridges on LAD was 17 (1.75%), on proximal segment of LAD, 792 (81.39%) on middle segment of LAD and 155 (15.39%) on distal segment of LAD.

In the present study of 2015 angiograms of Andhra Pradesh population of south India we observed 64 myocardial bridges, a percentage incidence of 3.17%. All 64 myocardial bridges were located on the LAD of left coronary artery only. The segmental distribution of myocardial bridges were 04 (6.25%) on proximal segment of LAD, 56 (87.5%) on middle segment of LAD and 04(6.25%) on distal segment of LAD. The total percentage incidence of myocardial bridges was higher (3.17%) in the present study than that reported in the literature (Ayfer Mavi et al and LI Jion –Jun et). The incidence of MB on proximal segment of LAD was not reported by Ayfer Mavi et al where as LI Jion –Jun et al reported 1.75% which was less that that observed in the present study.

Abhilash et al [30], studied 10492 coronary angiograms in Kerala, region of south India. They observed 129 myocardial bridges (1.23%). The myocardial bridges were located on the LAD, diagonal, Septal and right coronary arteries. Among 129 patients 103(79.8%) were right dominant, 15 (11.6%) patients were left dominant and 11 (8.5%) patients were balanced or codominant. According to Abhilash, The mean length of myocardial bridges was 24.53mm. In present study out of 64 patients 51(79.6%) patients were right dominant, 12 (18.7%) patients were left dominant and 1 (1.5%) patient was co dominant. Our findings are similar to the findings of Abhilash et.al [31] for the dominance pattern in patients with myocardial bridges. In the present study the range of length of myocardial bridges is 3.13mm – 53.72mm. The mean length of myocardial bridges in males is 22.15mm and in females is 16.54mm.The overall mean length of myocardial bridges is 20.05 and standard deviation is 12.61 which is less than that reported by Abhilash et al [31].

In our study we found more myocardial bridges in males (40/64) when compare with females (24/64) which is similar to Harikrishnan et al [22] and Abhilash et al [31] reported in literature. According to pathophysiology of myocardial bridges if the length of myocardial bridges increases than the percentage of luminal reduction increases which further effects on ischemia. In our study angiographically we found more lengthy bridges but statistically we did not found significant difference between length of myocardial bridges with percentage of luminal reduction.

## CONCLUSION

The percentage incidence of MB's (3.17%) was more than that reported in other studies in India. In our study we found more lengthy myocardial bridges (53.72mm) in angiograms. More number of MB's was observed in male than in female (40 bridges in males& 24 bridges in females). The percentage of luminal reduction is more in females when compared to males. This suggests a higher risk of MI for female patients with MB. The percentage of luminal reduction is more in patients of 20-40 years of age (74.1%). In the bridging positive cases the luminal reduction is high in patients of right coronary dominance (67.1%).

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## REFERENCES

[1]. Reyman HC. Disertatio de vasis cordis propriis. Med Diss Univ Göttingen. 7th Sept 1737; 1–32.
[2]. Geiringer E. The mural coronary. Am Heart J 1951;41:359-68.
[3]. Portmann WC Iwig J. Intramural coronary vessels in the angiogram. Fortschr Rontgenstr,1960;92:129-133.[PubMed].

[4]. JuilliereY, Berder V, Suty-Selton C, Buffet P, Danchin N, Cherrier F. Isolated myocardial bridges with angiographic milking of the left anterior descending coronary artery: a long term follow up study. Am Heart J 1995:129(4):663-665.

[5]. Rossi.L, Danber.B, Nadasio.GP, Arbustini.F, ParisB, C.Vassanelli, C.Bounanno, A.Poppi. Myocardial bridges and ischemic heart disease. Eur Heart J 1980; 1(4): 239-245.

[6]. Kramer JR, Kitazume H, Proudfit WL, Sones FM. Clinical significance of isolated coronary bridges and frequent condition involving the left anterior descending artery. Am Heart J 1982;103(2):283-288.

[7]. Rajendra Prasad VK, Joseph T.John, Supriya NK. Occurrence and Anatomical Distribution of Myocardial Bridges and Co-relation with Sudden Death and Coronary Atherosclerosis. International journal of Recent Trends in science and Technology 2013 ;8(3): 238-239.

[8]. Loukas M, Curry B, Bowers M, Louis RG, Bartczak A, Kiedrowski M, Kamionek M, Fudalej M, Wagner T. The relationship of myocardial bridges to the coronary artery dominance in the adult human hearts. J Anat 2006;209(1): 43-50.

[9]. H.Saidi, WK Ongeti, and J Ogengo. Morphology of human myocardial bridges and coronary artery disease. Afr health sci,2010;10(3):242-247

[10]. Luis Ernesto Ballesteros Acuna ,Luis Miguel Ramirez, Saldarriaga Bladimir Tellez et al. Myocardial description and clinical implication of myocardial bridges: an anatomical study in Colombians. Arq. Bras.Cardiol 2009;92(4):242-248.

[11]. Bandyopadhyay M, Piyali Das, Karabi Baral, Puronjoy Chakroborty. Morphological study of myocardial bridges on the coronary arteries. Indian Journal of Thoracic and Cardiovascular Surgery 2010;26(3): 193-197.

[12]. Adam Kosinski, Marek Grzybiak. Myocardial bridges in the human heart: Morphological aspect. Folia Morphol 2001;60(1): 65-68.

[13]. Chandra sekhar KT & and Harsha BR. A cadaveric study on Muscle Bridges in human hearts. IJAPB 2015.2(3):1-6.

[14]. Ishii T, Hosoda Y. The significace of myocardial bridge upon atherosclerosis in the left anterior descending coronary artery. J Path 1986;148:279-291.[PubMed].

[15]. Laifer LI, Weiner BH. Percutaneous trans luminal coronary angioplasty of a coronary artery stenosis at the site of myocardial bridging. Cardiology 1991;79:245-248.[PubMed].

[16]. Kuhn FE, Rgan K. Mohler ER, III. Satler LF, Lu Dy. Rackley CE. Evidence for endothelial dysfunction and enhanced vasoconstrution in myocardial bridges. Am Heart J 1991;122:1764-1766.[PubMed].

[17]. Baptista CA, Didio LJ. The relationship between the directions of myocardial bridges and of the branches of the coronary arteries in the human heart. Surg Radiol Anat 1922;14:137-140.[PubMed].

[18]. Arjomand H, Alsalman J, Azian J, Admin D. Myocardial bridging of left circumflex coronary artery associated with acute myocardial infarction. J Invasive Cardiol 2000;12:431-4.

[19]. Angellini P,Leachman R, Autrey A. Atypical phasic coronary artery narrowing. Cathet Cardiovasc Diagn 1986;12:39-43.

[20]. Garg S, Brodison A, Chauhan A. Occlusive systolic bridging of circumflex artery. Catheter Cardiovasc Interv 2000;51:477-8.

[21]. Robert G, Irvin, MD. The Angiographic Prevelence of Myocardial bridging in Man. Chest 1982;81(2):198-202.

[22]. Harikrishnan S, Sunder KR, Tharakan J, Titus T, Bhat A, Sivasankaran S, Bimal F. Clinical and angiographic profile and follow-up of myocardial bridges: a study of 21 cases. Indian Heart J 1999;51(5):503-7.

[23]. Ozlem SORAN, Gulgun PAMIR, Cetin EROL, Cavit KOCAKAVAK and Irfan SABAH. The Incidence and Significance of Myocardial Bridge in a Prospectively Defined Population of Patients Undergoing Coronary Angiogram for Chest Pain. Tokai J Exp Clin Med 2000; 25(2):57-60.

[24]. Inigo Lozano , Jose A. Baz , Ramon Lopez Palop, Eduardo Pinar, Francisso Pico, Mariano Valdes, Mariano Larman and Jose L. Martinez Ubago. Long term Prognosis of Patients with Myocardial Bridge and Angiographic Milking of the Left Anterior Descending Coronary Artery. Rev Esp Cardiol 2002;55(4):359-64.

[25]. Teragawa, Fukuda Y, Matsuda K, Hidekazu Hirao, Yukohito Higashi, Togo Yamagata,Tetsuya Oshima, Hideo Matsuura, Kazuaki Chiyama. Myocardial bridging Increases the Risk of Coronary Spasm. Clin Cardiol 2003;26:377-83.

[26]. Cays S, Sezgin O, Gokhan Cihan, Halial L, Kisacik, Sute Korkmaz. Angiographic prevalence of myocardial bridging. Anadolu Kardiyol Derg 2006; 6:9-12.

[27]. Ayfer Mavi, Alper Sercelik, Resat Ayalp, Zarema Karben, Talantbek Batyraliev, Erdem Gumusburun. The Angiographic Aspects of Myocardial Bridges in Turkish Patients Who have Undergone Coronary Angiogram. Ann Acad Med Singapore 2008;37:49-53.

[28]. LI JJ, Shang ZL, Yao M, LI J, Yang YJ, Chen JL, Qiao SB, Ma WH, Qin XW, Liu HB, Wu YJ, Yuan JQ, Chen J, You SJ, Dai J, Xu B, Xia R and Gao RL. Angiographic prevalence of myocardial bridging in a defined very large number of Chinese patients with chest pain. Chinese Medical Journal 2008;121(5): 405-408.

[29]. R.Javadrashid, M.K. Tarzamni, N.Aslanabadi, M. Ghaffair, A.Sorteji. Myocardial bridging and coronary artery anomalies detected by ECG-gated 64-roe multidetector computed tomography angiography in symptomatic patients. Folia Morphol 2009;68(4):201-206.

[30]. QIAN Ju-ying, ZHANG Feng, DONG Min, MA Jian – ying, GE Lei, LIU Xue-bo, FAN Bing, WANG Qi-bing, CUI Shan-jing and GE Jun-bo. Prevalence and characterestics of myocardial bridging in coron-ary angiogram – data from consecutive 5525 patients. Chin Med J 2009;122(6):632-635.

[31]. Abhilash S P, Krishna kumar B, Praveen Velappan, Prabhanini Gupata, Sunitha Viswanathan, A.Geoege Koshy. Myocardial bridging. clinical and angiographic profile in last 5 years; a study of 129 cases. Kerala heart journal Nov.2010:9-13.

[32]. En- sen Ma, Guo-lin Ma, Hong-wei Yu, Wang Wu, and Kefeng Li. Assessment of myocardial bridge and Mural Coronary Artery Using ECG- Gated 256-Slice CT Angiography: A Retrospective Study. The scientific world journals 2013:1-6. Art. ID 947876.

33]. Jothi SD.R.S, Hemanth Kumar K, Rajeswara Rao N, Jacintha Antony, Sai Sucheethra, SreeLekha D. Myocardial Bridges Over Interventricular Branches Of Coronary Arteries. Jour of Med. Sc & tech 2012;1(1):26-29.

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