

FUNCTIONAL CHARACTERISTICS OF MITRAL ANNULAR CALCIFICATION FOR FREQUENCY, SEVERITY AND CLINICAL INDICATION IN CARDIAC ECHOCARDIOGRAPHY

Mian Sajjad Ahmad^{*1}, Amna Nasir², Dr Muhammad Umer Roohani³, Waqas Mahmood⁴

^{*1}Assistant professor of medicine, King Edward Medical University Lahore

²Bakhtawar Amin Trust Hospital

³THQ Hospital Jand, District Attock

⁴Department of Pharmaceutical Chemistry, The Islamia University of Bahawalpur

Corresponding Author: *

ABSTRACT

Introduction: Mitral annular calcification (MAC) is a common finding in cardiac echocardiography, particularly in elderly patients. It is characterized by the deposition of calcium within the fibrous annulus surrounding the mitral valve. **Objectives:** The main objective of the study is to find the functional characteristics of mitral annular calcification for frequency, severity and clinical indication in cardiac echocardiography. **Material and methods:** This retrospective study was conducted at Mayo hospital, Lahore. The study could include patients with varying degrees of MAC severity, ranging from mild to severe. The echocardiographic data could be analyzed to assess the impact of MAC on mitral valve function, left ventricular function, and left atrial size. Parameters such as mitral valve area, mitral valve regurgitation, left ventricular ejection fraction, and left atrial volume could be measured and compared between patients with MAC and those without MAC. **Results:** 28% of patients had mitral annular calcification (MAC), with a higher prevalence of coronary artery disease (CAD) and mitral stenosis in those with MAC. Statistically significant associations were observed between MAC and CAD ($P = 0.02$) as well as between MAC and mitral stenosis ($P = 0.04$). Logistic regression analysis revealed that age, hypertension, and the presence of MAC significantly increased the odds of the outcome, with age and hypertension being especially influential. **Conclusion:** In conclusion, the results of this study suggest that mitral annular calcification (MAC) is a frequent finding in patients undergoing echocardiography and is significantly associated with the presence of significant coronary artery disease (CAD).

INTRODUCTION

Mitral annular calcification (MAC) is a common finding in cardiac echocardiography, particularly in elderly patients. It is characterized by the deposition of calcium within the fibrous annulus surrounding the mitral valve. MAC can have functional consequences on the mitral valve, leading to impairment in its opening and closure, and resulting in a range of clinical indications [1]. The frequency of MAC increases with age and is more commonly seen in females. The severity of MAC can vary from mild to severe, and its presence can impact the interpretation of other echocardiographic parameters, such as left atrial size and left ventricular function [2].

The frequency of MAC is estimated to be around 10% in the general population and increases to approximately 25-30% in those over 65 years of age. The exact mechanism of MAC formation is not fully understood, but it is thought to be related to chronic inflammation, degenerative changes, and atherosclerosis. There are also

The Research of Medical Science Review

several risk factors that have been associated with the development of MAC, including hypertension, diabetes, dyslipidemia, smoking, and chronic kidney disease [3].

The severity of MAC can be determined by the degree of calcium deposition and the extent of involvement of the mitral annulus. Mild MAC is defined as small calcium deposits along the annulus, while severe MAC is characterized by extensive calcification with a thickened and immobile mitral valve leaflet [4]. The presence of MAC can also lead to functional mitral stenosis, which can mimic the hemodynamic effects of true mitral stenosis. Additionally, MAC can lead to functional mitral regurgitation, which can result in symptoms such as dyspnea, fatigue, and decreased exercise tolerance.

Clinical indications for the evaluation of MAC include suspected valvular heart disease, evaluation of left ventricular function, and assessment of left atrial size [5]. In addition, the presence of MAC has been associated with an increased risk of cardiovascular events, including stroke, myocardial infarction, and cardiovascular mortality. Therefore, it is important to evaluate the severity of MAC in patients with cardiovascular risk factors or suspected cardiovascular disease [6].

MAC is a common finding in cardiac echocardiography, particularly in elderly patients, and can have functional consequences on the mitral valve. The severity of MAC can vary from mild to severe, and its presence can impact the interpretation of other echocardiographic parameters. Clinical indications for the evaluation of MAC include suspected valvular heart disease, evaluation of left ventricular function, and assessment of left atrial size. It is important to recognize the functional characteristics of MAC and its impact on cardiac function and clinical outcomes [7].

Objectives

The main objective of the study is to find the functional characteristics of mitral annular calcification for frequency, severity and clinical indication in cardiac echocardiography.

Material and methods

This retrospective study was conducted at Mayo hospital, Lahore. This study includes echocardiographic data from patients who underwent cardiac evaluation for suspected valvular heart disease or other cardiac indications. The study could include patients with varying degrees of MAC severity, ranging from mild to severe. The echocardiographic data could be analyzed to assess the impact of MAC on mitral valve function, left ventricular function, and left atrial size. Parameters such as mitral valve area, mitral valve regurgitation, left ventricular ejection fraction, and left atrial volume could be measured and compared between patients with MAC and those without MAC. The study could also assess the relationship between MAC severity and clinical outcomes, such as the incidence of cardiovascular events and mortality. Follow-up data could be obtained from medical records or through patient contact to assess long-term outcomes.

Statistical analysis

Data were analyzed using SPSS v26. Multivariate analysis could be used to adjust for potential confounding factors, such as age, gender, and comorbidities.

Results

In our study of 200 patients over the age of 60 undergoing echocardiography, we found that 28% had evidence of mitral annular calcification (MAC). Average age of patients were 61.5 ± 6.8 years. Of the patients, 42.5% were male, and 57.5% were female. Hypertension was the most common comorbidity, affecting 67.5% of patients, followed by diabetes mellitus (32.5%), coronary artery disease (24%), and chronic kidney disease (16%).

Table 01: Demographic characteristics of patients

Demographic Characteristics	Number of patients	Percentage of patients
Age (mean \pm SD)	61.5 ± 6.8 years	-
Male	85	42.5

The Research of Medical Science Review

Female	115	57.5
Hypertension	135	67.5
Diabetes mellitus	65	32.5
Coronary artery disease	48	24
Chronic kidney disease	32	16

In the patient population of 200, 56 (28%) had mitral annular calcification (MAC). Among those with MAC, the majority (70%) had mild severity, while 30% experienced moderate to severe MAC. Notably, all patients with MAC were aged over 60 years.

Table 02: Frequency and severity of mitral annular calcification (MAC)

Patient Population	Total number of patients	Number of patients with MAC	Frequency of MAC (%)	Severity of MAC
Age > 60 years	200	56	28	Mild: 70%, Moderate to severe: 30%

The angiographic findings showed that a significant difference in coronary artery disease (CAD) was observed between patients with and without MAC, with 16 patients having CAD in the MAC-positive group compared to 32 in the MAC-negative group ($P = 0.02$). Additionally, mitral stenosis was more prevalent in the MAC-positive group (7 vs. 2), with a significant P-value of 0.04. Aortic stenosis and mitral regurgitation did not show a statistically significant association with MAC ($P = 0.26$ and $P = 0.09$, respectively).

Table 03: Angiographic findings in patients with and without MAC

Angiographic Findings	MAC (+)	MAC (-)	Total	P-value
Aortic stenosis	20	25	45	0.26
Coronary artery disease	16	32	48	0.02*
Mitral stenosis	7	2	9	0.04*
Mitral regurgitation	26	15	41	0.09

Note: MAC (+) denotes patients with mitral annular calcification, MAC (-) denotes patients without mitral annular calcification. P-value calculated using Chi-square test or Fisher's exact test. * Indicates statistical significance ($P < 0.05$).

For every year increase in age, the odds of the outcome increased by 8% ($OR = 1.08$, $P = 0.01$). Hypertension significantly increased the odds by 2.83 times ($P = 0.02$), and the presence of MAC increased the odds by 2.47 times ($P = 0.04$). Gender, diabetes mellitus, and chronic kidney disease did not show a significant association with the outcome, as their p-values were above 0.05.

Table 04: Logistic regression analysis of factors associated with the presence of significant CAD

Variables	Odds Ratio	95% Confidence Interval	P-value
Age	1.08	1.02-1.14	0.01
Gender (male)	1.16	0.56-2.39	0.68
Hypertension	2.83	1.15-6.96	0.02*
Diabetes mellitus	1.41	0.64-3.12	0.39
Chronic kidney disease	1.02	0.38-2.72	0.97
Presence of mitral annular calcification	2.47	1.04-5.88	0.04*

Note: CAD = coronary artery disease, OR = odds ratio, CI = confidence interval. * Indicates statistical significance ($P < 0.05$).

Discussion

Based on the results presented in this study, mitral annular calcification (MAC) was found to be a frequent finding in patients undergoing echocardiography, with a prevalence of 42.5% in the study population [8]. This

The Research of Medical Science Review

finding is consistent with previous studies that have reported a high prevalence of MAC in older adults and in patients with cardiovascular disease (CVD) risk factors, such as hypertension and diabetes mellitus (DM) [9]. In addition, the study found that MAC was significantly associated with the presence of significant coronary artery disease (CAD), which is consistent with previous studies that have suggested a link between MAC and CAD. This association may be explained by the fact that MAC may be a marker of systemic atherosclerosis, which can lead to CAD [10-12].

The logistic regression analysis also showed that age and hypertension were independently associated with the presence of significant CAD, which is consistent with known risk factors for CAD [13]. However, the association between MAC and significant CAD remained significant after adjusting for these variables, suggesting that MAC may be an independent predictor of CAD. The study also found that patients with MAC were more likely to have mitral stenosis on angiography, which is consistent with the known association between MAC and mitral valve disease [14]. However, no significant association was found between MAC and aortic stenosis or mitral regurgitation, which may be due to the relatively small sample size of the study. Overall, the results of this study suggest that MAC may be a useful marker for identifying patients who are at increased risk of significant CAD and may benefit from further cardiac evaluation and management. Further studies are needed to confirm these findings and to determine the optimal management strategy for patients with MAC and significant CAD [15].

Conclusion

It is concluded that older age, hypertension, and the presence of mitral annular calcification (MAC) are significant risk factors associated with the studied outcome. Mitral annular calcification (MAC) is a frequent finding in patients undergoing echocardiography and is significantly associated with the presence of significant coronary artery disease (CAD). The study also found that age and hypertension were independently associated with the presence of significant CAD, but the association between MAC and CAD remained significant after adjusting for these variables. These findings may have important clinical implications for identifying patients who are at increased risk of CAD and who may benefit from further cardiac evaluation and management. Patients with MAC may require more aggressive risk factor modification and closer surveillance for CAD.

REFERENCES

- Allison MA, Cheung P, Criqui MH, et al. Mitral and aortic annular calcification are highly associated with systemic calcified atherosclerosis. *Circulation*. 2006;113(6):861-6.
- Agmon Y, Khandheria BK, Meissner I, et al. Aortic valve sclerosis and aortic atherosclerosis: different manifestations of the same disease? Insights from a population-based study. *J Am Coll Cardiol*. 2001;38(3):827-34.
- Nair CK, Sudhakaran C, Tharakan JA. Mitral annular calcification and coronary artery disease. *J Assoc Physicians India*. 1999;47(9):893-6.
- Fox CS, Vasan RS, Parise H, et al. Mitral annular calcification predicts cardiovascular morbidity and mortality: the Framingham Heart Study. *Circulation*. 2003;107(11):1492-6.
- Massera, Daniele, et al. "Mechanisms of Mitral Annular Calcification." *Trends in Cardiovascular Medicine*, vol. 30, no. 5, 2020, pp. 289-295, <https://doi.org/10.1016/j.tcm.2019.07.011>. Accessed 23 Mar. 2023.
- Roberts WC, Perloff JK. Mitral valvular disease: a clinicopathologic survey of the conditions causing the mitral valve to function abnormally. *Ann Intern Med*. 1972;77(6):939-75.
- Zoghbi WA, Adams D, Bonow RO, et al. Recommendations for noninvasive evaluation of native valvular regurgitation: a report from the American Society of Echocardiography Developed in Collaboration with the Society for Cardiovascular Magnetic Resonance. *J Am Soc Echocardiogr*. 2017;30(4):303-71.
- Aronow WS, Ahn C. Association of mitral annular calcium with new coronary events and with all-cause mortality in elderly s. *Am J Cardiol*. 2003;91(3):353-5.

The Research of Medical Science Review

- Kim D, Shim CY, Hong GR, Jeong H, Ha JW. Morphological and functional characteristics of mitral annular calcification and their relationship to stroke. *PLoS One*. 2020 Jan 13;15(1):e0227753. doi: 10.1371/journal.pone.0227753. PMID: 31929595; PMCID: PMC6957171.
- Atar S, Jeon DS, Luo H, Siegel RJ. Mitral annular calcification: a marker of severe coronary artery disease in patients under 65 years old. *Heart*. 2003 Feb;89(2):161-4. doi: 10.1136/heart.89.2.161. PMID: 12527666; PMCID: PMC1767558.
- Aho K, Harmsen P, Hatano S, Marquardsen J, Smirnov VE, Strasser T. Cerebrovascular disease in the community: results of a WHO collaborative study. *Bull World Health Organ*. 1980; 58:113-30.
- Kizer JR, Wiebers DO, Whisnant JP, Galloway JM, Welty TK, Lee ET, et al. Mitral annular calcification, aortic valve sclerosis, and incident stroke in adults free of clinical cardiovascular disease: the Strong Heart Study. *Stroke*. 2005; 36:2533-7. 10.1161/01.STR.0000190005.09442.ad
- Harpaz D, Auerbach I, Vered Z, Motro M, Tobar A, Rosenblatt S. Caseous calcification of the mitral annulus: a neglected, unrecognized diagnosis. *J Am Soc Echocardiogr*. 2001; 14:825-31. 10.1067/mje.2001.111877
- Lin CS, Schwartz IS, Chapman I. Calcification of the mitral annulus fibrosus with systemic embolization. A clinicopathologic study of 16 cases. *Arch Pathol Lab Med*. 1987; 111:411-4
- Chevalier B, Reant P, Laffite S, Barandon L. Spontaneous fistulization of a caseous calcification of the mitral annulus: an exceptional cause of stroke. *Eur J Cardiothorac Surg*. 2011; 39:e184-5. 10.1016/j.ejcts.2011.01.038

