JACC: CASE REPORTS VOL. 30, NO. 3, 2025

RHYTHM DISORDERS AND ELECTROPHYSIOLOGY

CLINICAL CASE

Arrhythmic Mitral Valve Prolapse

Late Correct Diagnosis

Shayan Mirshafiee, MD, Zahra Aamaraee, MD, Mohammadreza Eftekhari, MD, Reza Mollazadeh, MD

ABSTRACT

BACKGROUND Arrhythmic mitral valve prolapse (AMVP) is a relatively new entity in the field of arrhythmia and sudden cardiac death.

CASE SUMMARY A 19-year-old female patient with a history of aborted sudden cardiac death, initially diagnosed as idiopathic ventricular fibrillation in 2012 and received implantable cardioverter defibrillator. Gradual decline in left ventricular ejection fraction and receiving multiple appropriate implantable cardioverter defibrillator shocks was odd for us. After review of her past medical documents and detailed cardiac imaging diagnosis of AMVP was made.

DISCUSSION Individuals with AMVP are prone to left ventricular mechanical dispersion, leading to an increased susceptibility to malignant ventricular arrhythmias independent of the severity of MR.

TAKE-HOME MESSAGE This case emphasizes the importance of reviewing old documents and consultation with multiple subspecialists. Follow-up may alter the primary suspected diagnosis. (JACC Case Rep. 2025;30:103093)

CASE PRESENTATION

The patient was a 19-year-old woman without any family history of sudden cardiac death (SCD), who was successfully resuscitated from ventricular fibrillation (VF) in 2012 (aborted SCD) and subsequently underwent mechanical ventilation, inotropes and broad-spectrum antibiotics for a duration of 3 weeks in the intensive care unit.

Upon achieving clinical stability and completing requisite assessments, the patient, initially diagnosed with idiopathic VF considering gross normal cardiac

TAKE-HOME MESSAGES

- This case highlights the importance of multidisciplinary action in the diagnosis and treatment of complicated patients.
- Review of old documents by different subspecialists in the field of cardiology may be needed.
- Systematic mitral valve analysis and the adjunction of ECG Holter monitoring in case of MVP diagnosis to look for AMVP phenotype and risk factors should be emphasized.

From the Department of cardiology, School of medicine, Imam Khomeini Hospital Complex, Tehran University of Medical Sciences, Tehran, Iran.

The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

Manuscript received October 11, 2024; revised manuscript received November 21, 2024, accepted December 2, 2024.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2024.103093

ABBREVIATIONS AND ACRONYMS

AMVP = arrhythmic mitral valve prolapse

CMR = cardiac magnetic resonance

ECG = electrocardiogram

ICD = implantable cardioverter-defibrillator

LGE = late gadolinium enhancement

LV = left ventricle

MR = mitral regurgitation

MAD = mitral annular disjunction

MVP = mitral valve prolapse

SCD = sudden cardiac death

VA = ventricular arrhythmia

VF = ventricular fibrillation

VT = ventricular tachyarrhythmia

findings (electrocardiogram [ECG], echocardiography, and negative family history of SCD), received an implantable cardioverter-defibrillator (ICD) before being discharged.

In 2015, she presented with tenderness, erythema, and purulent discharge from the ICD pocket site, leading to a diagnosis of cardiac implantable electronic devices infection. Consequently, surgical extraction of leads and the generator was performed, followed by the implantation of a new ICD on the opposite (right) side.

During the period between surgical extraction and the new ICD implantation, cardiac magnetic resonance (CMR) was performed. Our colleague specialized in cardiac imaging noted late gadolinium enhancement (LGE) in inferobasal region of the left ventricle (LV) with mild LV systolic dysfunction and mild-to-moderate mitral regurgitation (MR).

ECG in follow-up showed normal atrial pacing (probably owing to treatment with amiodarone and a beta-blocker) and capturing with intrinsic atrio ventricular conduction. Small q wave and fragmented QRS were also evident in inferior leads.

During the follow-up evaluations, the ICD analysis revealed some episodes of malignant ventricular arrhythmia (VA), which were successfully treated with antitachycardia pacing or ICD shocks (**Figure 1**).

INVESTIGATIONS AND MANAGEMENT

Throughout a span exceeding 10 years since her initial evaluation, there has been a gradual decrease in the LV ejection fraction. During the most recent hospitalization in 2022 at our center,[1] which was due to recurrent ICD shocks, advanced echocardiography revealed a decrease in LV ejection fraction to 45% to 50% with moderate LV enlargement, severe mitral valve prolapse (MVP) (mostly posterior leaflet), and moderate MR. A significant mitral annular disjunction (MAD) of 10 mm was also detected (**Figure 2**, Video 1).

Regarding the diagnosis of arrhythmic MVP (AMVP) and MAD complex, the patient's 2015 CMR underwent reevaluation. The results indicated LGE in the inferobasal wall of LV and left posteromedial papillary muscle, MVP and MAD, consistent with the AMVP diagnosis (**Figure 2**, Video 2).

VISUAL SUMMARY

First year	Aborted sudden cardiac death, prolonged ICU stay and receiving ICD owing to probable idiopathic VF owing to overall normal cardiac structure
Third year	Device infection, surgical lead extraction, performing cardiac MRI showing scar with diagnosis of nonischemic cardiomyopathy and receiving new transvenous ICD from contralateral side
Sixth year	Receiving appropriate ICD shock owing to ventricular arrhythmia, up titration of antiarrhythmic
Seventh year	Receiving appropriate ICD shock owing to ventricular arrhythmia, up titration of antiarrhythmic
Tenth year	Admitted owing to recurrent appropriate ICD shocks, echocardiography showed decrease in left ventricular ejection fraction, review of 2015 CMR showed obvious mitral annular disjunction and prolapse

CMR = cardiac magnetic resonance; ICD = implantable cardioverter defibrillator; ICU = intensive care unit; MRI = magnetic resonance imaging; VF = ventricular fibrillation.

OUTCOME AND FOLLOW-UP

After the successful control of arrhythmia, ICD reprogramming, and multidisciplinary discussion within the heart team, she was ultimately discharged in a favorable general condition with an uptitration of oral anti-arrhythmic medications. Fortunately, her clinical status has demonstrated stability over the subsequent 2 years.

DISCUSSION

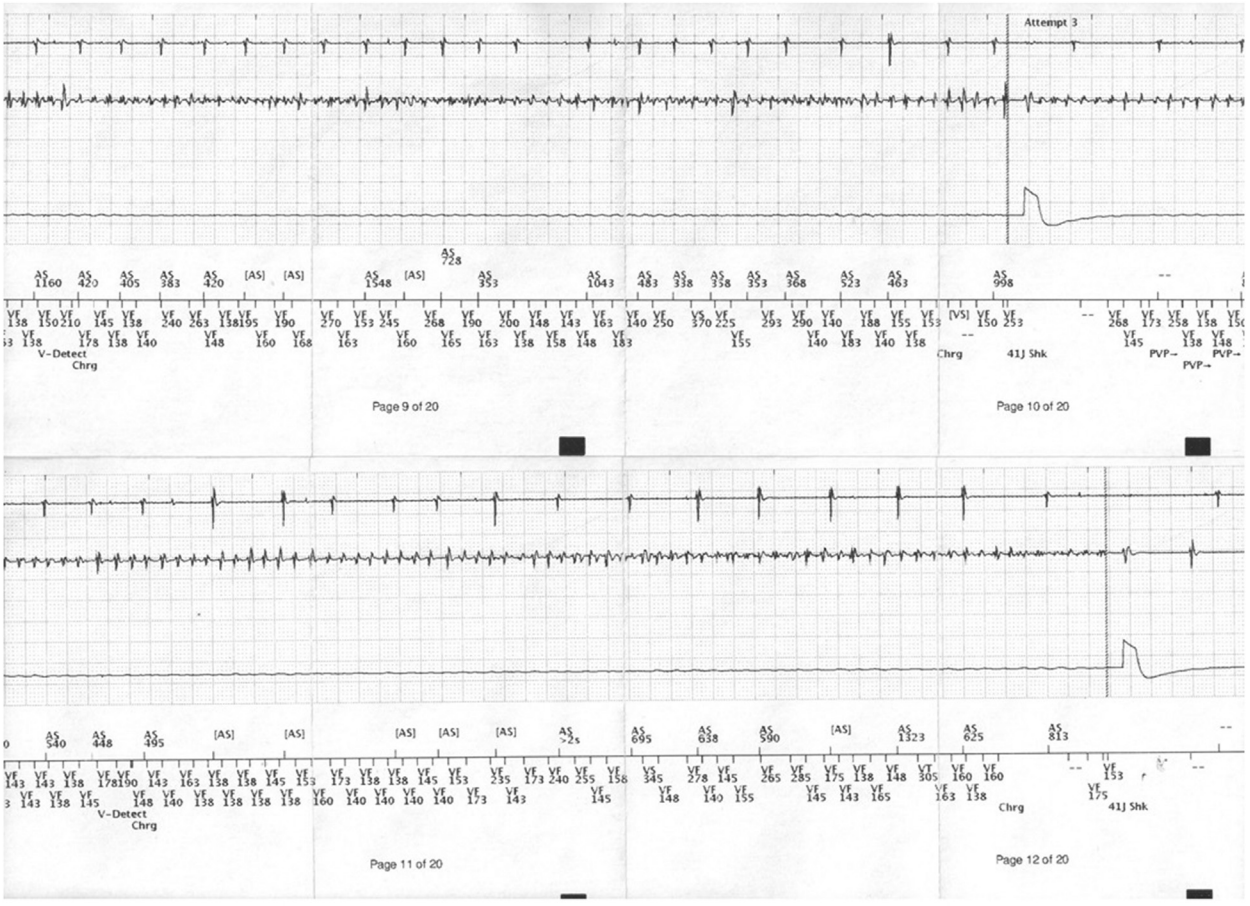
MVP, the most common valvular heart disease, can present with various nonspecific symptoms. Syncope, in particular, serves as a high-risk feature. In patients with MVP who experience syncope, VAs occur in 35% of cases, which is 10 times more than those have never experienced syncope.[1]

Individuals with AMVP are prone to encountering progressive myxomatous changes and LV mechanical dispersion, leading to an increased susceptibility to malignant VAs independent of MR severity.[2] This is a new entity and well-defined for <10 years. At the time of initial presentation in 2012 and even in 2015, physicians in charge all missed the correct diagnosis.

It has been recommended to consider arrhythmic MVP in individuals who present with syncope, frequent ventricular ectopy, or aborted SCD. Although the risk stratification is still challenging, these patients should be evaluated by history taking, physical examination, 12-lead ECG, and 24-hour ECG Holter monitoring.[2]

T-wave inversion on the inferior and lateral leads is seen in 65% arrhythmic MVP cases which is most likely due to abnormal repolarization resulted from fibrotic changes in specific regions.[3] Ventricular premature beats originating from papillary muscles or mitral annulus are characterized by right bundle branch block morphology with inferior or superior axis based on anterior or posterior regions involvement.[4] Upon reviewing the initial ECGs and cardiac monitoring of our patient just before ICD

FIGURE 1 **ICD EGM**



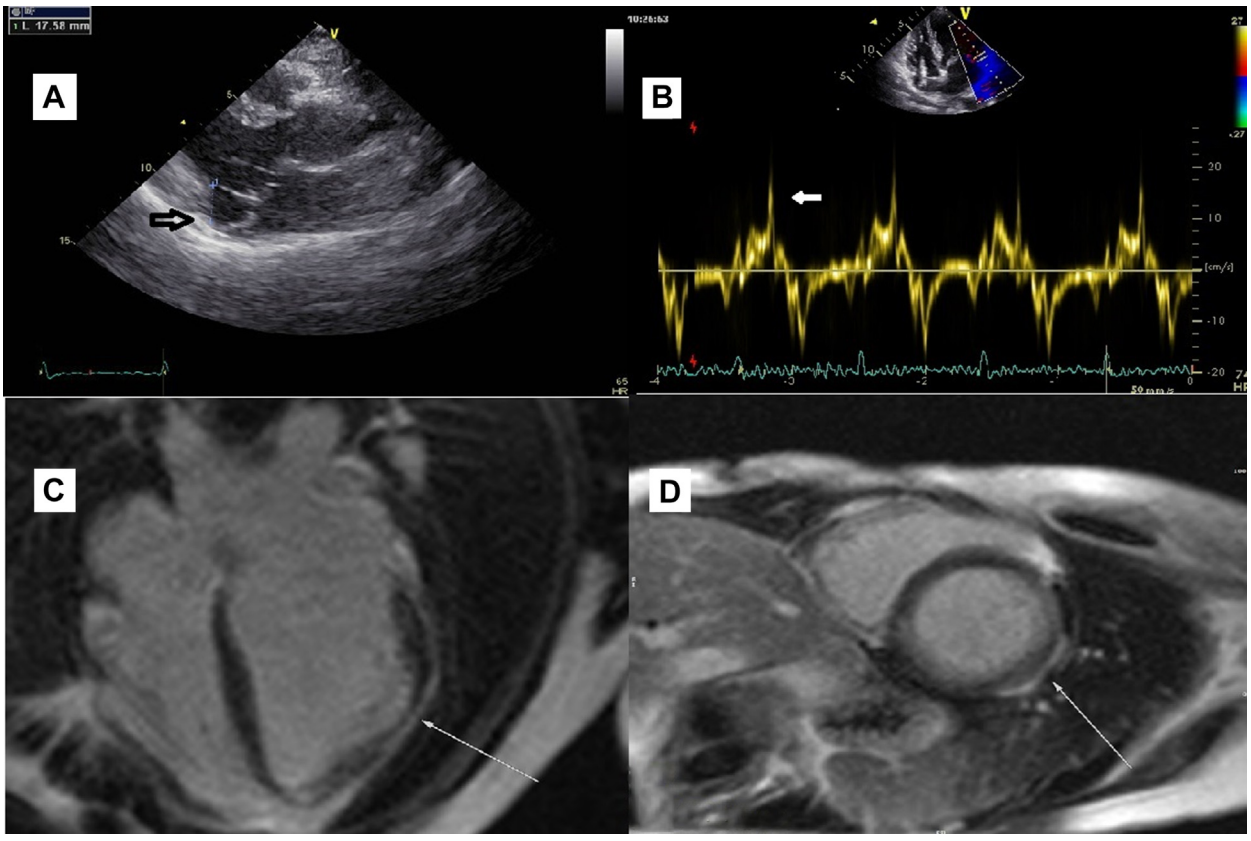
Intracardiac EGM showing rapid irregular ventricular rhythm in the ventricular channel that was electrically cardioverted with a biphasic 41-J shock. EGM = electrogram.

implantation, the described changes were observed, but were overlooked by the primary physician.

A standard 24-hour ECG Holter monitoring is recommended in all individuals with MVP and periodic ECG Holter monitoring as routine follow-up may be advised. In the evaluation of ECG, 24-hour ECG Holter monitoring, or implantable loop recorders in specific cases, those with hemodynamically tolerated ventricular tachyarrhythmias (VT), polymorphic nonsustained VTs, and rapid monomorphic nonsustained VTs are considered as high-risk MVPs and should be monitored closely.[5]

Advanced detailed echocardiography should include leaflets and annular characterization, MR grading, MAD detection, and LV functional assessment by 3D models and global longitudinal strain measurement.[6] In recent years, there has been a notable increase in research focusing on the characteristics of MAD.[7] In this condition, mitral annulus migrates to left atrium and MV leaflets attached to the left atrial free wall instead of the LV wall. In contrast, a high-velocity spike configuration in the systolic signal of tissue doppler imaging of the mitral valve annulus was detected in the patient (Pickelhaube sign). Substantial evidence supports the association between MAD and various arrhythmias, including repeated premature ventricular contractions, nonsustained and sustained VA, and SCD.[8,9] Hence, it is recommended that physicians consider the detection of MAD in patients undergoing monitoring for MVP, particularly in individuals with history of unexplained syncope, family history of SCD, or PVCs displaying right bundle branch block morphology.

FIGURE 2 **Transthoracic Echocardiographic Images**



(A) Obvious mitral annular disjunction (arrow). (B) Tissue Doppler imaging of left ventricle lateral wall shows high velocity systolic signal (known as pickelhaube or spike helmet sign) (arrow). (C and D) Cardiac magnetic resonance imaging of the patient showing late gadolinium enhancement in the basal inferolateral of left ventricle.

CMR should be performed in all individuals who experienced malignant VA or survived SCD.[10] LGE presence in papillary muscles and patchy fibrosis in inferobasal region of LV are associated with increased VAs, with these areas serve as arrhythmia substrates.[11] LV dysfunction, remodeling, and fibrosis can be determined by T1 mapping. The association between MAD and increased VAs is established, yet the precise relationship between MAD severity, width, extension, and VAs remains undetermined,[12]

Medically treating individuals with asymptomatic MVP to prevent arrhythmias is not beneficial,[10] Yet, beta-blockers and anti-arrhythmic agents are valuable for symptom control in symptomatic patients. It is important to recognize that medical therapy in isolation is inadequate in preventing SCD, necessitating the evaluation of ICD implantation in high-risk patients (aborted SCD or those with syncope deemed to be due to VA). In our case, the patient underwent implantation of an ICD owing to documented VF in absence of reversible causes. Catheter ablation is also promising just to alleviate PVC triggering VT or VF or eliminating arrhythmic substrate in patients receiving multiple ICD shocks.[13]

CONCLUSIONS

Owing to the high prevalence of MVP and the emerging data indicating a higher incidence of malignant arrhythmias in these patients, meticulous evaluation and close monitoring are essential for detecting high-risk features. The concurrent presence of MAD in these individuals should be taken into consideration, as it can escalate the likelihood of VAs. Clearly, there is a pressing need for larger-scale

studies in the realm of preventing and treating cardiac events in this population.

ACKNOWLEDGMENTS The authors express their sincere gratitude to all health care workers who contributed to this study.

ADDRESS FOR CORRESPONDENCE: Dr Reza Mollazadeh, Associate Professor of Cardiology, Department of Cardiology, School of Medicine, Imam Khomeini Hospital Complex, Tohid Square, POB: 1419733141, Tehran, Iran. E-mail: mollazar@yahoo.com.

REFERENCES

1. Han HC, Ha FJ, Teh AW, et al. Mitral valve prolapse and sudden cardiac death: a systematic review. *J Am Heart Assoc*. 2018;7(23):e010584.

2. Dejgaard LA, Skjølsvik ET, Lie ØH, et al. The mitral annulus disjunction arrhythmic syndrome. *J Am Coll Cardiol*. 2018;72(14):1600–1609.

3. Nalliah CJ, Mahajan R, Elliott AD, et al. Mitral valve prolapse and sudden cardiac death: a systematic review and meta-analysis. *Heart*. 2019;105(2):144–151.

4. Enriquez A, Baranchuk A, Briceno D, Saenz L, Garcia F. How to use the 12-lead ECG to predict the site of origin of idiopathic ventricular arrhythmias. *Heart Rhythm*. 2019;16(10):1538–1544.

5. Tani T, Konda T, Kitai T, Ota M, Furukawa Y. Mitral annular disjunction-a new disease spectrum. *Cardiol Clin*. 2021;39(2):289–294.

6. Members WC, Otto CM, Nishimura RA, et al. 2020 ACC/AHA guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *J Am Coll Cardiol*. 2021;77(4):e25–e197.

7. Essayagh B, Sabbag A, El-Am E, Cavalcante JL, Michelena HI, Enriquez-Sarano M. Arrhythmic mitral valve prolapse and mitral annular disjunction: pathophysiology, risk stratification, and management. *Eur Heart J*. 2023;44(33):3121–3135.

8. Lee AP-W, Jin C-N, Fan Y, Wong RH, Underwood MJ, Wan S. Functional implication of mitral annular disjunction in mitral valve prolapse: a quantitative dynamic 3D echocardiographic study. *JACC Cardiovasc Imaging*. 2017;10(12):1424–1433.

9. Essayagh B, Sabbag A, Antoine C, Benfari G, Yang L-T, Maalouf J, et al. Presentation and outcome of arrhythmic mitral valve prolapse. *J Am Coll Cardiol*. 2020;76(6):637–649.

10. Sabbag A, Essayagh B, Barrera JDR, et al. EHRA expert consensus statement on arrhythmic mitral valve prolapse and mitral annular disjunction complex in collaboration with the ESC Council on valvular heart disease and the European Association of Cardiovascular Imaging endorsed cby the Heart Rhythm Society, by the Asia Pacific Heart Rhythm Society, and by the Latin American Heart Rhythm Society. *Europace*. 2022;24(12):1981–2003.

11. Vergara P, Scarfò I, Esposito A, et al. Characterization of the electrophysiological substrate in patients with Barlow's disease. *J Cardiovasc Electrophysiol*. 2021;32(12):3179–3186.

12. Essayagh B, Iacuzio L, Civaia F, Avierinos J-F, Tribouilloy C, Levy F. Usefulness of 3-tesla cardiac magnetic resonance to detect mitral annular disjunction in patients with mitral valve prolapse. *Am J Cardiol*. 2019;124(11):1725–1730.

13. Mahmoodi E, Haqqani HM. Arrhythmic mitral valve prolapse syndrome and ventricular arrhythmias: a comprehensive review and the role of catheter ablation. *J Cardiovasc Dev Dis*. 2024;11(7).

KEY WORDS arrhythmic mitral valve prolapse, ventricular arrhythmias, mitral annular disjunction, sudden cardiac death

APPENDIX For supplemental videos, please see the online version of this paper.