Ultrasonography Profile of Myxomatous Mitral Valve Disease on An 11-Year-Old Poodle

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Abstract

Myxomatous mitral valve disease (MMVD) is a prevalent inherited mitral valve condition. This study aimed to evaluate the clinical manifestation of the cardiac condition MMVD in Poodles. Using ultrasonography (USG), this study examined the characteristics, progression, diagnosis, and treatment of MMVD in an 11-year-old Poodle. This case study was conducted at the Veterinary Teaching Hospital, School of Veterinary Medicine and Biomedical Sciences, utilizing a Chison Ebit60 with an 8–12 MHz curvilinear probe. The dog was positioned in the right parasternal recumbency position, and the long axis (RPLA) and short axis (RPSA) views were obtained. In the evaluation and diagnosis, B-Mode, M-Mode, and Color Flow Doppler (CFD) modes of ultrasonography were performed. The dog presented with coughing, and the physical examination revealed a grade 3–4 murmur. Based on B-mode cardiac monitoring, sinus arrhythmia, mitral valve thickness, and prolapses indicate MMVD. Mitral regurgitation was indicated by a decrease in heart rate and an increase in the left ventricle internal dimension (LVIDd) on the M-mode. Meanwhile, CFD's representation of turbulent flow confirmed mitral regurgitation results. The rise in blood pressure confirmed the presence of hypertension. Class B2 MMVD in Poodles has consequently been diagnosed in this case.

Keywords: MMVD, Poodle, regurgitation, sinus arrhythmia, ultrasonography

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INTRODUCTION

Myxomatous mitral valve disease (MMVD) is a prevalent cardiac disease of the mitral or bicuspid valves the prevalence is astoundingly high, with a frequency of 30–70% in dogs older than 10 years. The lifelong occurrence of MMVD in several of these breeds is close to 100% (Oyama *et al*., 2020). It is common in small dog breeds, like Yorkshire Terrier, Miniature Poodle, Miniature Schnauzer, Dachshund, Cavalier King Charles Spaniel, Chihuahua, and mixed breed dogs. The comparable genetic background, clinical appearance, and high occurrence of this disease in particular small dog breeds suggest a genetic origin (Fox, 2012).

MMVD is diagnosed by auscultation and echocardiography. Physical examination findings depend on whether the dog has developed, asymptomatic, or symptomatic MMVD with congestive heart failure (CHF). Cardiac auscultation is the most important part of a heart disease physical exam (Kim *et al*., 2017). Dogs diagnosed with mitral valve disease (MMVD) exhibit mitral regurgitation as a result of degeneration and enlargement of the mitral valve leaflets. The patient has a left apical systolic murmur indicative of mitral regurgitation associated with MMVD. The auscultation of the cardiac system has the potential to identify MMVD in small-breed dogs that are in the middle to advanced stages of life (Hezzell, 2018).

Mitral regurgitation can be visualized during echocardiography utilizing Color-Flow Doppler (CFD) imaging. Echocardiography is the gold-standard test to confirm the diagnosis of MMVD and assess the degree of individual cardiac chamber enlargement. Ultrasound enables the cardiac muscle function and the cardiac valves to be assessed in detail, which provides information

that is important to both diagnosis and treatment (Summerfield, 2018). The American College of Veterinary Medicine (ACVM) suggests echocardiography to detect MMVD (Keene *et al*., 2019). However, echocardiography is not always readily available. Left atrium (LA) enlargement is a critical determinant in determining the risk of present or future CHF, thereby highlighting the need to monitor LA size. In addition, the detection of LA enlargement can assist in differentiating between individuals in stages B1 and B2 (Vezzosi *et al*., 2021).

Mitral valve degeneration affects dogs with MMVD, which is the most frequent natural canine disease. The defective valve allows blood to regurgitate into the left atrium with each pump. Asymptomatic MMVD may be difficult to detect. Therefore, early identification may be possible by studying MMVD treatment at the Veterinary Teaching Hospital, School of Veterinary and Biomedical Medicine (RSHP SKHB IPB). This study aimed to evaluate the clinical presentation of the heart condition, MMVD in Poodles. Using ultrasonography, this study examined the features, progression, diagnosis, and therapy of MMVD in an 11-year-old Poodle.

MATERIALS AND METHODS

Study Period and Location

This case study was conducted at the Veterinary Teaching Hospital, School of Veterinary Medicine and Biomedical Sciences, IPB University (RSHP SKHB IPB) between August 2022 and March 2023.

Animal

An 11-year-old female Poodle was generally suspected of having MMVD due to its genetic makeup. In the evaluation and diagnosis, ultrasonography (USG) (Chison Ebit60) with B-Mode, M-Mode, and CFD mode was utilized (Utami and Noviana 2019).

Treatment and Evaluation

Physical examination was done by taking the signalment, anamnesis, and vital signs. Both heart and lungs were examined through auscultation using a stethoscope. The blood pressure was taken by using a sphygmomanometer with a dog cuff. Following, the fur around the thorax region was shaved. By placing the dog at right lateral recumbency, place the curvilinear probe applied with ultrasound gel, in a slightly oblique position in the third to fourth intercostal space at the level of the costochondral junction. The excessive gel on the chest was then cleaned with tissues.

Echocardiography was performed with recommended practices. For qualitative examination, both right parasternal long axis (RPLA) and right parasternal short axis (RPSA) views were utilized. B-mode and M-mode readings were extracted from cine loops of three consecutive systolic and diastolic cardiac cycles. The CFD was utilized to examine the presence of valvular insufficiencies and ventricular outflow tract obstruction. Comparing cardiac dimensions and indices to breed/weight-specific reference ranges. Guidelines for transducer frequencies range from 8–12 MHz for cats and dogs of comparable size (Penninck and d'Anjou 2015).

RESULTS AND DISCUSSION

The cardiac rhythm displayed a sinus arrhythmia pattern. In dogs, sinus arrhythmia is often a normal sinus rhythm that manifests as an irregular rate where the R-R interval changes more rapidly than normal (0.12 seconds) (Table 1). The valve structure and valve movement revealed thickening and prolapsed. The mitral valve leaflet degenerates due to myxomatous degeneration, making it difficult for the valve to open and shut properly. The interventricular septa (IVS) and the left ventricle wall (LVW) were presented to be hypoechoic. Between the pericardium and heart, the left ventricular internal dimension (LVID) was anechoic (Figure 1). Ultrasonography typically reveals the visceral layer of the cardiac to be hyperechoic (DeFrancesco, 2021). M-mode echocardiography is widely used for assessing left ventricular (LV) function using a short or long-axis cut through the left ventricle (Figure 2), as well as measuring cardiovascular events such as left ventricular ejection times using a long-axis cut through the

Table 1. Two-dimensional Brightness mode (B-mode)

Parameter	Examination Result
Heart Rhythm	Sinus arrhythmia
Endocard Layer	Smooth and thin
Valve Structure	Mitral valve thickening
Valve Movement	Mitral valve prolapse

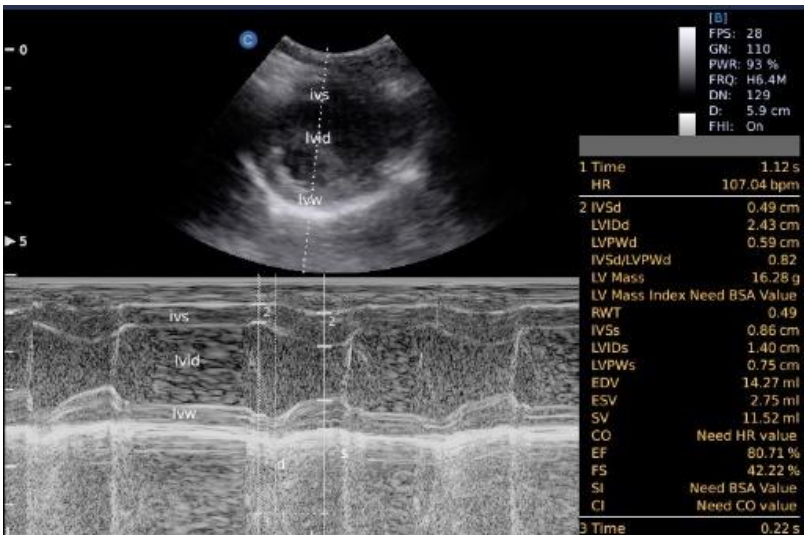

Figure 1. Short-axis view on B-mode and M-mode of left cardiac of a poodle. IVSd= interventricular septa-diastole, IVSs= interventricular septa-systole, LVIDd= left ventricle internal dimension-diastole, LVIDs= left ventricle internal dimension-systole, LVWd= left ventricle wall-diastole, LVWs= left ventricle wall-systole.

Table 2. Two-dimensional Motion mode (M-mode)

Parameter	Examination Result	[a]Normal Value	[b]Normal Value
HR (BPM)	107	70–145	116–148
IVSd (mm)	4.9	4–6	5.5–6.7
LVIDd (mm)	24.3	16–28	16.49–20.02
LVPWd (mm)	5.9	4–6	5.0–6.4
IVSs (mm)	8.6	6–10	7.23–9.3
LVIDs (mm)	14.0	8–16	8.99–11.17
LVPWs (mm)	7.5	6–10	6–10
ET (second)	0.22	0.15–0.35	0.15–0.35
EDV (mL)	14.27	-	-
ESV (mL)	2.75	-	-
SV (mL)	11.52	-	-
CO (L/min)	1.232	-	-
EF (%)	80.70	55–85	55–85
FS (%)	42.20	25–45	41–48
LAAs (mm)	10.0	8–18	9.5–12.15
AoDd (mm)	11.3	8–13	9.9–12.4
LAAs:AoDd	1.1: 1	1: 1	1: 1

[a](Penninck and d'Anjou, 2015)

[b](Isayama et al., 2022).

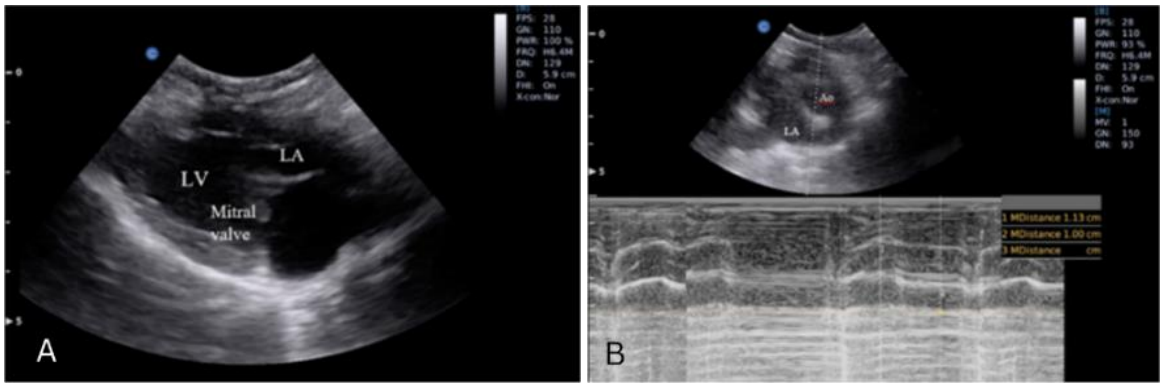

Figure 2. Long axis and short axis view upon M-mode examination. (A) Long axis: Mitral valve, left ventricle (LV) and left atrium (LA). (B) Right parasternal short axis of LAAs: AoDd ratio of 1.1 : 1.

Table 3. Color Flow Doppler mode (CFD mode)

Parameter	Examination Result
Atrio-Ventricular Valve	Mitral valve regurgitation
Semilunar Valve	No regurgitation/turbulence color

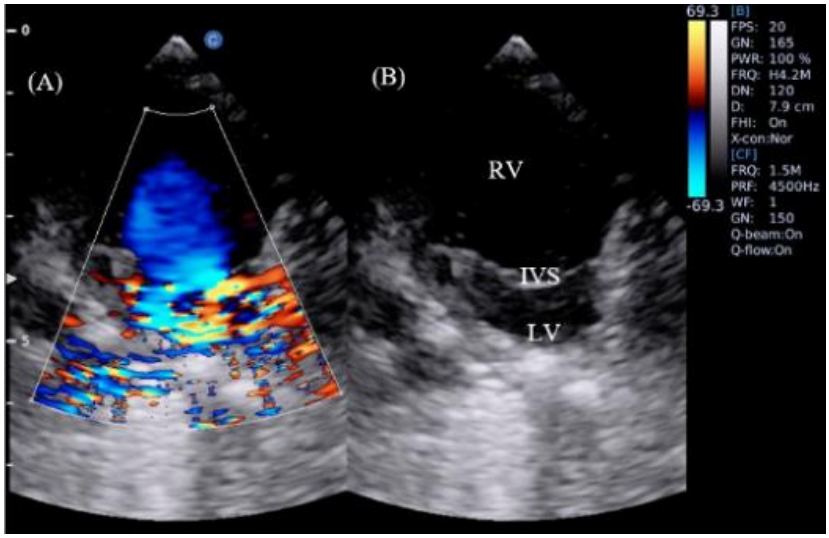

Figure 3. Color Flow Doppler (CFD) across a short axis view. (A) Atrioventricular valve shows turbulence flow; (B) Atrioventricular valve without CFD. RV= Right ventricle, LV= left ventricle, IVS= interventricular septum.

aortic valves. The data obtained from the basis of M-mode echocardiography was used to calculate the end-diastolic volume (EDV) and end-systolic volume (ESV) left ventricle, stroke volume (SV), cardiac output (CO), ejection fraction (EF), and fractional shortening (FS) (Noviana and Kurniawan 2013).

The normal value cited by Penninck and d'Anjou (2015), there were parameters with a higher boundary range. The left ventricular posterior wall of diastole (LVPWd) due to an upsurge in diastolic filling, provokes the length of the muscle cells in the walls of the cardiac chambers to enhance the Frank-Starling relationship (Table 2). The Frank-Starling relationship posits that in healthy hearts, increases in end-diastolic volume lead to a gradual augmentation in peak ventricular pressure and stroke volume. The modulation of this relationship is influenced by various physiological inputs and is frequently impaired in cases of heart failure (Hanft *et al*., 2019). This can

be observed in the greater contraction from each cardiac muscle cell during systole whenever the cells were lengthened during diastole (Kampourakis and Irving 2021). Hence, the IVS thickness and left ventricle wall of diastolic (LVWd) can be used to determine the presence of LV hypertrophy.

Since the LVPWd is at the upper boundary of the normal range, it could indicate an elevation of pressure within the heart. Table 2 demonstrates that the several features have different typical ranges (Isayama *et al*., 2022). The lower-than-normal heart rate supports MMVD-induced bradycardia. The regurgitant aperture is the primary effect of MMVD on blood flow, causing more blood to flow backward and less blood to flow out of the heart (Öztürk *et al*., 2016). Left Ventricle Internal Dimensions during diastole (LVIDd) and systole (LVIDs) were both higher than the normal value. Long-term mitral regurgitation may lead the left ventricle to have an excessively large capacity, as it must accommodate both the stroke volume and the amount of blood that leaks backward with each heartbeat. In response, the left ventricle becomes larger and more active. Table 2 demonstrates that the heart rate and LVID have different typical ranges (Isayama *et al*., 2022), while Figure 2 shows the long-axis and short-axis view upon M-mode examination.

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The most prevalent method of assessing mitral regurgitation in MMVD dogs is using CFD sonography. Blue represents flow away from the transducer, while red represents flow toward it. Faster velocity is indicated by the lighter color of the mixture, named turbulence. Figure 3 depicts CFD turbulence in the atrioventricular valve, which indicates regurgitation. In MMVD cases, the theoretical outcomes of a loose mitral leaflet demonstrated blood backflow into the left ventricle. This semilunar valve has no regurgitation or turbulence, as presented in Table 3. The usual range for small dogs is 130/60 mmHg, thus 166/123 indicates hypertension. Pulmonary hypertension is an extremely frequent complication of MMVD, which can occur as the primary consequence of severe mitral valve regurgitation or as a form of distinct illness (Keene *et al*., 2019). This occurs due to increased pressure in the pulmonary veins as well as the left atrium (LA). Pulmonary hypertension caused by left cardiovascular disease depends on right ventricle health. High stress will cause right ventricular hypertrophy, which maintains blood flow. If the right ventricle's systolic performance is inadequate, right-sided congestive heart failure or systemic signs of low right-sided cardiac output will be visible (Pankov 2021).

The results of the patient point to Class B2 MMVD. For B2 class MMVD, Keene *et al*. (2019) prescribed 0.25–0.3 mg/kg peroral q12h Pimobendane. Nutritional treatment such as magnesium functions as a cofactor in several enzymatic reactions within the organism, exerting its influence on vital processes such as glucose and energy metabolism, protein synthesis, adenosine triphosphate (ATP) generation and utilization, as well as cardiovascular performance (Laflamme, 2022). Patients who have a large left atrium (LA) or B2 monitoring result should take Angiotensin-converting enzyme inhibitors (ACEI) as well. Dogs with stage B2 heart enlargement may benefit from treatment before symptoms of heart failure arise.

It was revealed that dogs in MMVD stages B1 and B2 have reduced morbidity and mortality. Preclinical MMVD is not a benign condition, as infected dogs have a wide range of outcomes and a high percentage die during investigation (Keene *et al*., 2019). Cardiac murmurs increase mortality risk. Heart murmur indicates the worst outcome when cardiac death and heart failure class

advancement are considered as a single goal. The best predictor of cardiac death is mild left atrial enlargement, and symptoms of heart failure include cough and high Emax.

CONCLUSION

In conclusion, B-mode cardiac monitoring, sinus arrhythmia, mitral valve thickness, and prolapse indicate MMVD in this case. The M-mode revealed a reduction in heart rate and escalated in the internal dimension of the left ventricle, which was indicative of mitral regurgitation. While the depiction of turbulent flow by CFD supports the findings of mitral regurgitation. The rise in blood pressure validated the hypertension diagnosis. Therefore, the diagnosis was determined that the patient had Class B2 MMVD. Treatment with pimobendane, fish oil, and ACEI was most recommended. The prognosis for Class B2 MMVD was favorable.

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AUTHORS' CONTRIBUTIONS

TPW and DN: Conceptualization and drafted the manuscript. TPW, AW, FSM, BNI, and DN: Performed the treatment, evaluation and preparation tables and figures. All authors have read, reviewed, and approved the final manuscript.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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