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A Case Report: Myxomatous Mitral Valve Disease in a Shih Tzu

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ABSTRACT

Myxomatous Mitral Valve Disease (MMVD) is a degenerative condition of the mitral valve where it weakens and causes regurgitation, eventually leading to cardiac remodeling. Jason, a seven-year-old male Shih Tzu weighing 7.5 kg, was presented with a persistent cough and exercise intolerance lasting over a month. A physical examination revealed a Grade II/VI heart murmur. Radiography and echocardiography were performed as part of the laboratory examinations. Radiography demonstrated cardiac remodeling, with a VHS of 10.3 viscerocranial, an intercostal space of 3, and a VLAS of 2.3. Echocardiography unveiled left atrial enlargement, mitral valve regurgitation, and a reduction in heart function. The dog was treated with Pimobendan (Cardisure® 10mg, Dechra, England) as an inodilatator at 0.25mg, Enalapril Maleate 0.5mg/kg (Tenace® 5mg, Combiphar, Indonesia), and furosemide (Farsix® 40mg, Fahrenheit, Indonesia) at 2 mg/kg via oral route twice a day over the course of seven days. Thereafter, the dose was reduced to 1.5 mg/kg PO twice a day for seven days, and eventually once a day for the remainder of the seven days. Following the three-week treatment, there was a significant reduction in the frequency and intensity of coughing.

Keywords: Chronic Heart Failure, Dog, Mitral Regurgitation, Myxomatous Mitral Valve Disease.

INTRODUCTION

Myxomatous mitral valve disease (MMVD) is the most common acquired cardiovascular disorder in dogs, particularly affecting small to medium-sized breeds (Trofimiak and Slivinska, 2021) with an average adult weighting <9 kg (Isayama et al., 2022). Myxomatous mitral valve disease primarily involves progressive degeneration of the mitral valve within the left atrium and ventricle of the heart. This degeneration leads to various structural and functional abnormalities,

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including mitral valve prolapse and regurgitation, ultimately resulting in congestive heart failure (CHF) in advanced stages (Lam et al., 2021). As the disease progresses, the mitral valve becomes incompetent as it fails to close completely, allowing blood to flow backward into the left atrium during ventricular contraction, leading to regurgitation and left atrial and ventricular enlargement (MacGregor, 2014). The consequence of an untreated mitral valve regurgitation is the enlargement of both the left atrium and ventricles.

These structural changes can lead to the appearance of clinical signs such as coughing, exercise intolerance, and syncope that may become more apparent as the disease progresses. Most dogs experience the onset of a recognizable murmur of mitral valve regurgitation years before the clinical onset of CHF (Keene et al., 2019). A cardiac murmur can be heard upon auscultation of the thoracic area due to the disturbance of blood flow by the thickening of the mitral valve. The loudest point of a cardiac murmur can be heard in the left apical area of the heart (Jessie-Bay and Khor, 2018). Crackling lung sound can also be heard during auscultation, as it is the compensatory mechanism of the heart. Increased leaked volume over time may cause pressure build up in the left atrium, transmitting an upstream to the lungs and leading to pulmonary edema (MacGregor, 2024). This can later be confirmed with thoracic radiography as the first-line diagnostic tool for dogs with suspected pulmonary edema and cardiac enlargement due to cardiac disease.

The management and treatment of MMVD aim to delay the onset of CHF and improve quality of life. According to the American College of Veterinary Internal Medicine (ACVIM), treatment for MMVD is a combination of pimobendan, an ACE inhibitor, and furosemide for stages C and D of the disease. Burchell and Schoeman (2014) reported that pimobendan had a clear benefit compared to benazepril in treating MMVD. Furthermore, pimobendan has also been shown to improve the outcome of dilated cardiomyopathy which is often a complication of MMVD in dogs.

MEDICAL RECORD

Signalements and Anamnesis

A seven-year-old male Shih Tzu dog named Jason, weighing 7.5 kg, was presented with coughing, lethargy, and exercise intolerance that had lasted for more than a month. A history of syncope within the same month was also reported by the owner. Coughing was non-productive, with a frequency of around 15 episodes of coughing throughout the day and night. The dog's eyes were both abnormal and the cause was unknown as the dog was already in such condition when the owner rescued him about five months prior.

In the shelter, Jason lived with 70 other dogs and only one dog with the same symptoms. According to the care-taker, the dog has been vaccinated and dewormed, and had good appetite and drank well. The diet consisted of a mixture of rice, boiled sweet potato, and dry food. Most of the time, the dog is left to roam free in the yard and spends its nighttime inside the house to sleep. The dog had not been treated with medication for its symptoms.

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Figure 1. Jason the Shih Tzu showing the abnormal size of the right eye and reduced in activity.

Physical Examination

Upon physical examination, the dog was calm and alert; his heart rate and temperature were normal, but there was a reduction in his pulse and respiration rate. The mucosal membrane of the gingiva was slightly cyanotic, and age was determined to be around seven years old from a dental assessment. The dog's eyes were both abnormal and had poor eye reflexes, with the right eye showing an obvious reduction in size and the left eye having a cloudy corneal appearance. Thoracic auscultation revealed heart murmur Grade II/VI with the maximum point of intensity at the left heart apex and crackling noise on both sides of the lungs during inspiration. The pre-assessment status is presented in Table 1.

Table 1. Jason Dog's Pre-assessment Status Check Result

No	Type of Inspection	Result	Referral Value	Description
1	Body Temperature (°C)	38.2°C	37.8-39.5	Normal
2	Heart Rate (times/minutes)	108/minute	60-160	Normal
3	Pulse (times/minute)	72/minute	76-128	Decreased
4	Respiration Rate (times/minute)	20/minute	24-42	Decreased
5	Capillary Refill Time (seconds)	<2	<2	Normal

Laboratory Examination

Thoracic radiographs and echocardiograms were performed to find any cardiac remodeling. Assessment of cardiac remodeling is done using the Vertebral Heart Scale (VHS) and Vertebral Left Atrial Score (VLAS). The VHS of 10.3 indicates a slight heart enlargement on a Shih Tzu. The normal VHS of a Shih Tzu is 9.30 $\pm$ 0.50 v (Tangpakornsak et al., 2023).

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Pulmonary edema was seen in the increased opacity in the lung parenchyma.

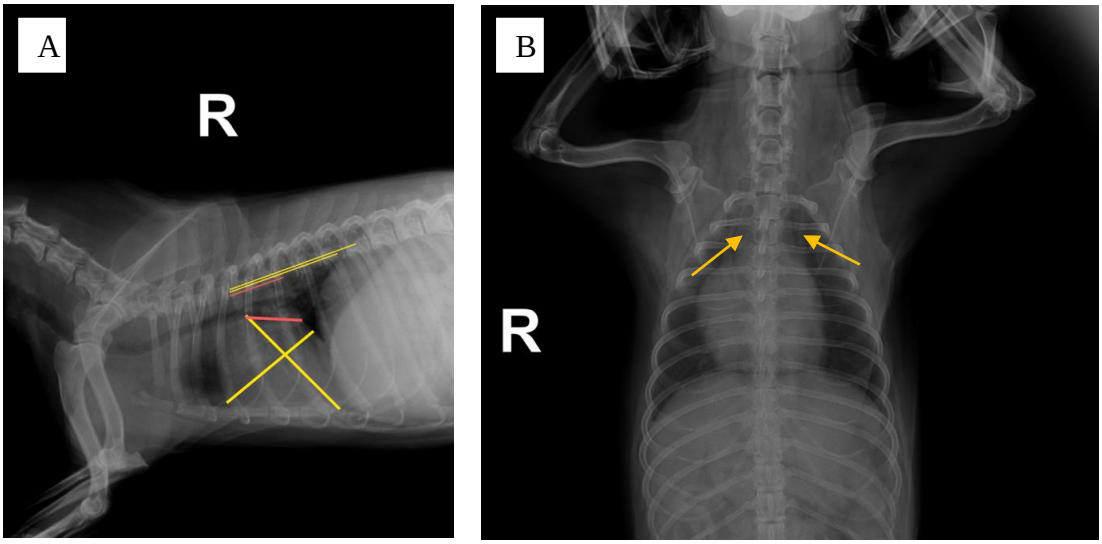

Figure 2. Thoracic radiograph of right lateral recumbency (A) and ventrodorsal view (B) show VHS of 10.3 (yellow lines), VLAS of 2.3 (red lines), and higher opacity in the lungs (arrows)

An echocardiograph revealed an abnormal valve structure. The posterior and anterior leaflets of the mitral valve were thickening and showing signs of prolapse. This resulted in the disruption of the blood back flow from the left atrium to the left ventricle, which can be seen in the color flow Doppler echocardiograph. Left atrial appendage-systole (LAAs) was slightly higher and left atrial (LA): aorta (Ao) ratio of 1.29 cm are both evidence of left atrial enlargement.

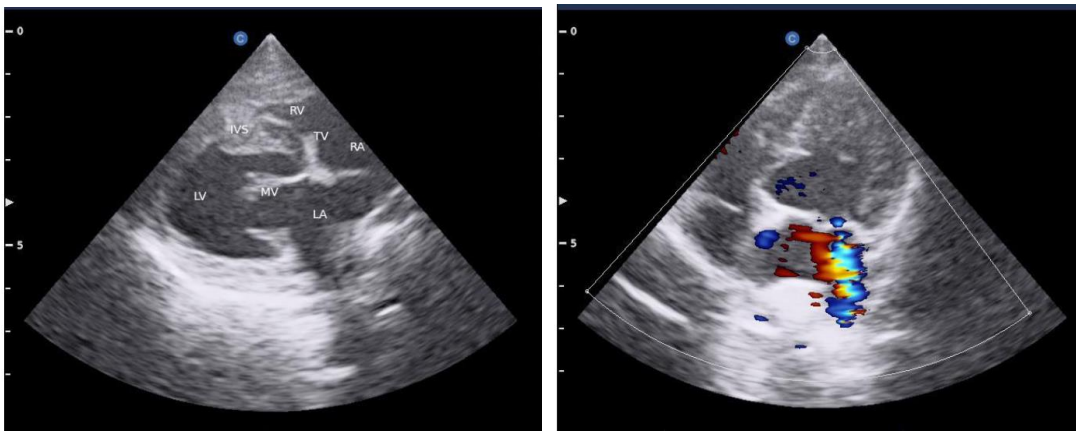

Figure 3. Echocardiograph parasternal long axis view shows thickening of the mitral valve with sign of prolapse which resulted in regurgitation showed by the mixing of color during color flow Doppler inspection

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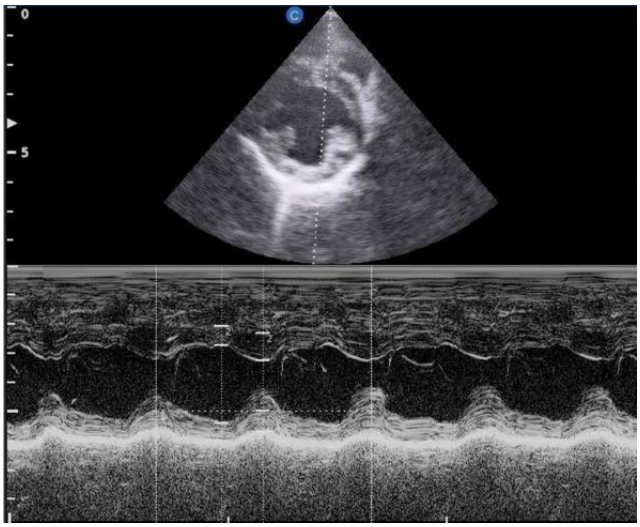

Figure 4. Echocardiograph of B-mode and M-mode shows the size of left ventricle is within normal range.

Table 2. Ultrasonographic Values Using Brightness-mode (B-mode)

Brightness-mode (B-mode)					
Parameter		**Examination result**		**Normal Value**	
HR	Heart Rate	121.77	BPM	70-145	BPM
IVSTd	Inter -Ventricular Septa-diastole	0.66	cm	0.4-0.9	cm
LVIDd	Left Ventricle Internal Dimension-diastole	2.67	cm	2.2-3.1	cm
LVPWd	Left Ventricle Posterior Wall- diastole	0.62	cm	0.4 - 0.9	cm
IVSTs	Inter-Ventricular Septa-systole	0.94	cm	0.7 - 1.2	cm
LVIDs	Left Ventricle Internal Dimension-systole	1.73	cm	1.2 - 2.2	cm
LVPWs	Left Ventricle Posterior Wall- systole	0.73	cm	0.7 - 1.3	cm
ET	Ejection Time		second	0.15-0.35	second
EDV	End Diastolic Volume	18.99	ml		ml
ESV	End Systolic Volume	5.20	ml		ml
SV	Stroke Volume	13.79	ml		ml
CO	Cardiac Output	1599.91	ml/min		ml/min
EF	Ejection Fraction	72.62	%	55 - 75	%
FS	Fractional Shortening	35.06	%	28 - 45	%
LAAs	Left Atrial Appendage-systole	**1.97**	cm	1.1 - 1.8	cm
AoDd	Aortic Diastolic Diameter	1.52	cm	1.2 - 1.8	cm
LAAs:AoDd		**1.29**		<1.2	
Ra		1.37	cm	1.1 - 1.8	cm
Ra : Ao		0.90		<1.2	

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Results of complete blood count of the dog were unremarkable.

Table 3. Complete blood count examination of Jason dog.

Parameter	Unit	Result	Referral Value	Description
WBC	$10/l^9$	14.18	6.00-17.00	Normal
Lymphocyte	$10/l^9$	1.29	1.00-4.80	Normal
RBC	$10/l^{12}$	5.96	5.50-8.50	Normal
HGB	g/dl	12.2	12.0-18.00	Normal
MCH	pg	84	19.5-24.5	Normal
MCHC	g/dl	20.4	31.0-39.0	Normal
RDWc	%	16.6	14.0-20.0	Normal
RDWs	fl	39.1	-	Normal
MPV	fl	9.0	3.9-11.1	Normal

Notes: WBC (*White Blood Cell*); RBC (*Red Blood Cell);* HGB (*Hemoglobin*); MCH (*Mean Corpuscular Hemoglobin*); MCHC (Mean Corpuscular *Hemoglobin Concentration)*; RDW (Red Cell Distribution Width); MPV (Mean Platelet Volume).

Diagnosis and Prognosis

Based on the anamnesis, physical examination, and confirmed results of the laboratory examinations, the dog was diagnosed with myxomatous mitral valve disease (MMVD) with a fair prognosis.

Therapy

The dog was prescribed an angiotensin-converting enzyme (ACE) inhibitor, Enalapril Maleate 0.5 mg/kg (Tenace® 5mg, Combiphar, Indonesia) PO, as a vasodilatator twice daily. Pimobendan (Cardisure® 10mg, Dechra, England), was given as an inodilatator at 0.25mg/kg twice a day orally on an empty stomach. Diet was changed to solely dry food (Happy Dog®, Germany). For pulmonary edema, a loop diuretic of furosemide (Farsix® 40mg, Fahrenheit, Indonesia) was planned for three weeks. The first given dose of furosemide at 2 mg/kg per oral (PO) twice a day for seven days, then tapered to 1.5 mg/kg PO twice a day for seven days, and further reduced to once a day for seven days.

DISCUSSION

The mitral valve is more susceptible than the tricuspid valve to myxomatous degeneration, resulting in MMVD (Kim et al., 2017). The mitral valve is responsible for ensuring blood flows from the left ventricle to the left atrium with no regurgitation. However, there is a tendency for mitral valve disease to undergo degeneration, which might result in prolapse. Myxomatous mitral valve disease is the most commonly acquired cardiac disease and the most frequent cause of congestive heart failure (CHF) in dogs. Cardiac remodeling on the left side of the heart takes place as the disease advances. When the heart's ability to expand reaches its limit, it leads to a subsequent increase in left

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atrial (LA) pressure. This increase in LA pressure results in higher pulmonary capillary pressure, which in turn triggers pulmonary edema and congestion (Lam et al., 2021). The progression of MMVD leads to congestive heart failure (CHF) and will cause exercise intolerance, syncope, cyanosis, hypertension, pulmonary edema, and arrhythmia (Kim et al., 2017).

The first clinical sign of MMVD is the presence of a heart murmur during auscultation, which is caused by the insufficiency of the valve to close properly, resulting in the regurgitation of blood flow from the left atrium back to the left ventricle. Progressive deformation of the valve structure eventually prevents effective coaptation, allowing regurgitation (valve leakage). The consequence of valvular regurgitation is an increase in the workload of the heart, leading to ventricular remodelling, and eventually ventricular dysfunction (Keene et al., 2019). In this case, heart murmur Grade II/VI was heard with the loudest point in the left apical of the heart, consistent with mitral regurgitation (Cote et al., 2015).

To confirm the cause of the murmur, thoracic radiography was performed to find any signs of enlargement or other cardiac remodelling. According to Widyananta et al. (2017), three measuring methods of the heart were performed with the thoracic radiograph: (1) the intercostal space method, (2) the height of the heart method, and (3) the vertebral heart score (VHS) method. Intercostal space of 3 was obtained and this is still considered within the normal range (2.5-3.5) according to Gugjoo et al. (2013). The VHS of 10.3 indicates a slight heart enlargement in a Shih Tzu. The normal VHS of a Shih Tzu is 9.30 $\pm$ 0.50 v (Tangpakornsak et al., 2023). A recent study by An et al. (2023) also found stage C of MMVD dogs has a range of VHS of 9.1-11.7 v. Pulmonary edema was also seen in the thoracic radiograph, which is a sign of CHF of MMVD origin. Due to the nature of MMVD's tendency to cause anatomical alteration in the left atrium, another method of radiographic measurement that can be done is vertebral left atrial size (VLAS). In this case, the VLAS obtained is 2.3 which does not indicate enlargement of the left atrium, which should be >3.0 for a dog weighing 8 kg (Keene et al., 2019). However, there is an obvious appearance of ventricular enlargement, as the line barrier for the heart apex is not clear.

The echocardiograph provides a definitive real diagnosis of the heart condition, as it evaluates the structure of the heart as well as provides a more thorough assessment in regard to the degree of right or left atria enlargement, end diastolic volume, ejection fraction, and fractional shortening (Jessie-Bay and Khor, 2018). In stage B2, the American College of Veterinary Internal Medicine (ACVIM) criteria for an asymptomatic dog that should be met are echocardiographic LA:Ao in the right-sided short axis view in early diastole $\geq$1.6, left ventricular internal diameter in diastole, normalized for body weight (LVIDDN) $\geq$1.7, and radiographic VHS of >10.5. However, VHS ranges vary from breed to breed. In this case, the physiological changes that happened were an increase in left atrial appendage-systole and LA:Ao, 1.97 cm and 1.29 cm, respectively. The color flow Doppler in the parasternal long axis view confirms the

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regurgitation of the mitral valve. Overall, the result of the echocardiograph is left atrial enlargement, regurgitation on the mitral valve, and decreased heart function. However, an echocardiograph was obtained one week after treatment with heart disease medications.

According to the ACVIM guidelines, the staging system for MMVD is described in four basic stages of heart disease and treatment. Stage C describes dogs with a current or past clinical sign of heart failure caused by MMVD. Stage C might require hospitalization (C1) or show symptoms that are less severe enough for in-home therapy to be given (C2). Stage D refers to dogs with end-stage MMVD. Dogs in this stage do not respond well to standard treatment for the clinical signs of CHF and require advanced or specialized treatment strategies to remain clinically comfortable with their disease. In this case, the dog was put in the stage C2 category despite radiography and echocardiography results not meeting the criteria of stage B2 due to the presence of CHF clinical signs such as persistent coughing, pulmonary edema, a history of syncope, and slight cyanosis of the mucosa.

Therapy given is 0.25 mg/kg pimobendan (Cardisure® 10mg, Dechra, England) PO q12h as an inodilatator. Its use in dogs with MMVD is to counteract reduced contractility. Inodilatators act not only by increasing myocardial contractility but also by reducing systemic and pulmonary vascular resistance. This in turn results in an increase in left ventricular forward stroke volume and a reduction in left ventricular and atrial size (Atkins and Häggström, 2012). Another drug given is an ACE inhibitor, Enalapril Maleate 0.5 mg/kg (Tenace® 5mg, Combiphar, Indonesia) PO q12h. ACE inhibitors have a long-term inhibitory effect on ACE activity and have been shown to improve clinical signs in dogs with CHF (Sakatani et al., 2016). Enalapril works by dilating blood vessels, reducing the workload on the heart, and improving blood flow. For pulmonary edema evident in the presence of crackles during lung auscultation, a loop diuretic of furosemide (Farsix® 40mg, Fahrenheit, Indonesia) is given 2mg/kg PO twice a day for seven days, then reduced to 1.5 mg/kg PO twice a day for seven days, and finally lastly once a day for seven days. The combination of pimobendan, ACE inhibitor, and furosemide is given as recommended by ACVIM consensus for patient in stage C2 category.

In conclusion, based on anamnesis, signalment, physical examination, and laboratory examinations such as radiography and echocardiography, Jason dog was diagnosed with MMVD with a fair prognosis. After three weeks of treatment with pimobendane, enalapril, and furosemide, coughing reduced to only several coughing episodes during the night and morning. Which means there was a reduction in frequency and intensity of coughing and the return of energy as the dog was visibly more active. The consumption of pimobendan and enalapril should be continued, ideally for the rest of his life.

CONCLUSION

Jason, a dog, presented with coughing lethargy, and exercise intolerance and was diagnosed with myxomatous mitral valve

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disease. Radiography and echocardiograph showed cardiac enlargement and mitral regurgitation related to the diagnosis. Treatment of pimobendan, enalapril, and furosemide was prescribed as described by ACVIM consensus guidelines. The three-week treatment resulted in an overall improvement of symptoms. The consumption of pimobendane and enalapril is to be continued for lifetime to reach the treatment goals of prolonging lifespan and improving quality of life. This concludes that the disease is manageable but requires a long-term intake of medications and routine health examination to assess the progress of the disease.

ETHICS APPROVAL

This case report did not need ethical clearance as the study was done according to the medical record of Udayana University Laboratory of Veterinary Internal Medicine. Data of medical records, physical examinations, and laboratory diagnostics, including haematology, radiography, and echocardiography, were performed by certified veterinarians or under supervision of certified veterinarians.

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