



Echocardiographic morphologic changes in chordae tendineae- mitral valve system and pulsed Doppler mitral flow indices study in dogs with mitral valve disease

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Abstract

Echocardiographic morphologic assessment of chordae tendineae- mitral valve system and mitral flow pulsed Doppler studies were carried out in dogs with mitral valve disease. Statistically significant increase in E/A ratio and thickening of anterior mitral valve leaflet was observed as predominant changes during pulse wave Doppler and 2-D echocardiographic studies in the mitral valvular diseased group of dogs when compared to the control group.

Keywords: Chordae tendineae, mitral valve, E wave

Stratification of mitral flow disturbances with pulsed Doppler and the 2-D echocardiographic assessment of chordae tendineae- mitral valve system is a subject of clinical importance for determination of the degree of severity of mitral disease. This is particularly important in the light of treatment outcomes in preclinical, asymptomatic patients with mitral valve diseases. Lebel *et al.* (2019) reported that a substantial proportion of both dogs and humans remain in the preclinical stage of mitral valve disease for an extended period whereas, others experience progressive disease and clinical development of congestive heart failure (CHF). The present study was conducted to estimate and document the echocardiographic pulsed Doppler mitral flow indices and morphologic changes in chordae tendinea mitral valve system in dogs with mitral valve disease (MVD).

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Materials and methods

The study was designed and conducted in the Department of Veterinary Clinical Medicine, Ethics and Jurisprudence, College of Veterinary and Animal Sciences, Mannuthy. Dogs presented to the Teaching Veterinary Clinical Complex (TVCC), Mannuthy and University Veterinary Hospital, Kokkala with clinical signs suggestive of cardiac disease *viz.*, cough, dyspnoea, exercise intolerance, weight loss, ascites, depression, lethargy, weakness, cyanosis and syncope were screened for the presence of mitral valvular disease.

Based on the clinical examination and echocardiographic studies, mitral valvular diseases were confirmed in nine dogs and were selected for the detailed study of pulsed Doppler and echocardiographic morphologic assessment of chordae tendineae- mitral valve system. Eligible dogs included in this study were those with a left apical systolic murmur and colour flow Doppler evidence of mitral regurgitation (Fig. 1).

Echocardiographic examinations were performed using an Esoate MyLabX8 exp ultrasound scanner with a multi-frequency phased array adult (2 to 3.5 MHz) and paediatric cardiac probe (6 to 10 MHz). The transducer was placed on the right and left precordium with dogs positioned in right and left lateral recumbency respectively. Left atrial diameter (LA) was measured from the right parasternal short axis view with 2 D-echocardiography. From the left apical view, by using pulsed wave Doppler, peak early (E_{max}) and late (A_{max}) mitral inflow velocity were measured at the tips of the mitral valve leaflets and their ratio (E: A) was calculated (Fig. 2). Ten apparently healthy dogs brought for general check-up were treated as control dogs to obtain normal parameters under study.

Results and discussion

A total of 251 dogs were presented

with clinical signs suggestive of cardiac diseases. Cardiac diseases were confirmed in 149 dogs. Among these, 40.94 per cent of dogs (61) were diagnosed with chronic mitral valve disease. Nine animals were selected for detailed study based on review availability. Exercise intolerance, weakness, difficulty in respiration, inappetence, syncope and non-specific seizures were the major complaints in varying degrees in these nine different cases. Ben *et al.* (2011) reported non-specific seizures in a Spitz affected with mitral valvular disease.

The various clinical examination findings observed in MVD dogs were systolic murmur, cyanotic mucous membrane (100 per cent), dyspnoea (88.89 per cent), tachypnoea and increased breath sounds (44.44 per cent), cardiac cachexia (33.33 per cent), crackles on lung auscultation, weak femoral arterial pulses with pulse deficit and peripheral oedema (22.22 per cent), jugular pulse (11.11 per cent). Similar observations were made by Unny (2014). Haggstrom *et al.* (2008) found that the grade of heart murmur was closely related to the severity of chronic mitral valvular insufficiency.

The mean values of rectal temperature in the control and MVD groups were 102.27 ± 0.17 and $102.46 \pm 0.36^\circ$ F respectively. The mean values of heart rate in the control and MVD groups were 107.3 ± 6.99 and 118.67 ± 9.18 bpm respectively. The mean values of pulse rate in the control and MVD groups were 98.62 ± 8.67 and 82.19 ± 6.63 bpm respectively. Pulse deficit was observed in 44.5 per cent of MVD animals. The mean values of respiration rate in the control and MVD groups were 39.90 ± 2.73 and 39.67 ± 3.90 / minute, respectively. However, no statistically significant differences could be obtained between control and MVD animals for vital parameters.

The left atrium diameter measured on the right parasternal short axis view is represented in Table 1.

Table 1. Mean values of diameter of LA in MVD and control dogs

Variables	Control	MVD	t-value	P-value
LA diameter (mm)	25.171 ± 0.965	26.265 ± 2.396	0.424 ^{ns}	0.681

** Significant at 0.01 level; ns non-significant

The mean values of LA in control dogs and MVD animals were 25.17 ± 0.96 and 26.265 ± 2.396 mm, respectively. Even though it was not statistically significant, the moderate increase in LA diameter observed in MVD animals might be due to chronic volume overload during haemodynamically significant chronic mitral regurgitation in MVD as observed by Boon (2011).

The mean mitral E and A wave velocities of MVD animals were 0.921 ± 0.077 and 0.508 ± 0.05 m/sec respectively. The mean values are displayed in Table 2. The mean mitral E/A ratio in MVD animals was significantly higher than that of the control group ($p=0.009$). Similarly, Okamoto *et al.* (2018) reported that peak E wave velocity was a useful prognostic predictor in asymptomatic degenerative MR. A high-velocity E-peak (>1.5 m/s) indicates marked elevation of LA pressure and is correlated with the severity of CHF and survival time in dogs with mitral valvular disease (Suh *et al.* 2019).

Transmitral flow analysis in the present study reflected a statistically significant increase in E/A in diseased animals when compared to the control group. This elevation in E/A might be either due to diastolic LV dysfunction or due to increased left ventricle filling pressure as opined by Schober *et al.* (2010). Nagueh (2020) documented high E/A, indicating the presence of diastolic dysfunction in congestive heart failure.

The majority of the animals (88.89 per cent) showed thickening and nodularity in anterior leaflets, while bilateral leaflets thickening and nodularity could be observed in 33.33 per cent of cases only (Fig.3). This finding agreed with the observations of Borgarelli *et al.* (2008) who reported similar observation. Chordae tendineae thickening was observed in



Fig. 1. Colour aliasing pattern of mitral regurgitation on colour Doppler imaging of 4 chamber view on left parasternal apical window (yellow arrow).

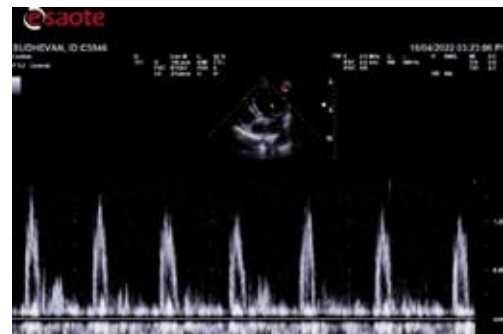


Fig. 2. Pulse Doppler mitral flow indicating E max and A max wave velocity. Red arrow: E max. Blue arrow: A max.



Fig. 3. Anterior and posterior mitral leaflet thickening on 4 chamber view on the left parasternal apical window. Red arrow: thickened anterior mitral leaflet. Blue arrow: thickened posterior mitral leaflet

Table 2. Comparison of pulsed Doppler Mitral parameters between control and MVD groups on initial day

Variables	Control	MVD	t-value	P-value
E Velocity (m/s)	0.839 ± 0.053	0.921 ± 0.077	0.907 ^{ns}	0.377
A Velocity (m/s)	0.571 ± 0.034	0.508 ± 0.05	1.091 ^{ns}	0.291
E: A	1.462 ± 0.043	1.911 ± 0.172	2.926 ^{**}	0.009

** Significant at 0.01 level; ns non-significant

33.33 per cent of cases in this study. Sisson *et al.* (1999), reported that the chordae tendineae are major components of the atrioventricular valve apparatus, and their involvement in any pathologic condition can compromise proper closure of the entire valve. They also observed that in most of the dogs with chordae tendineae rupture (96.5 per cent), the ruptured chordae tendineae had been attached to the anterior mitral valve leaflet.

Hence, the most statistically significant echocardiographic marker in our study to indicate the left atrium volume overload and left atrial pressure was the E/A ratio.

Therefore, the data from this study indirectly agrees with reports from other studies in both humans and dogs, which suggested that measurement of LA and E/A ratios were useful markers to determine the treatment necessity of asymptomatic mitral valvular disease. This is in accordance with the opinion of Okamoto *et al.* (2018) who reported that peak E wave velocity was a useful prognostic predictor in patients with asymptomatic degenerative mitral regurgitation.

Conclusion

Echocardiographic morphologic assessment of chordae tendineae- mitral valve system and mitral flow pulsed Doppler studies were carried out in dogs with mitral valve disease. Predominant morphologic changes like thickening in anterior mitral leaflet and statistically significant increase in E/A ratio were observed in the present study which indicated that these parameters could be used as promising diagnostic tools to initiate treatment strategies in dogs with asymptomatic or symptomatic mitral valvular disease.

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Conflict of interest

The authors declare that they have no conflict of interest.

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