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Diagnosis of Myxomatous Mitral Valve Disease (MMVD) in Aged Dogs

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ABSTRACT

Background: Aging is a biological process, which affects many body systems and increases susceptibility to disease that is associated with a reduction in immune response, a decline in cognitive function and a diminished functional reserve of the cardiovascular, pulmonary and renal systems. Diseases of heart or cardiovascular system represents a major component of geriatric medicine among which, myxomatous mitral valve disease is more common among geriatric dogs. The present study is keeping on record about the diagnosis of myxomatous mitral valve disease in geriatric dogs in and around Hyderabad, Telangana state.

Methods: A total of 1695 geriatric dogs presented to various clinics including university veterinary clinical complex of Hyderabad, Telangana state during 2015 to 2020 were considered for this study. After confirming that they were free from any other systemic disease, medium to large size breed dogs above 8 years with the history of exercise intolerance, dyspnoea and cough were selected. Diagnostic protocol included, auscultation, chest x-ray and 2d-echocardiography to confirm mitral valve degeneration.

Result: Myxomatous mitral valve disease was diagnosed in 427/695 geriatric dogs (61.43%) and were showing hyperechoeic thick mitral valve leaflets with kinking and prolapse. Further, echocardiography also revealed dilated left atrium and ventricle, hyperkinesis of interventricular septum, mitral valve degeneration and rupture of chordae tendineae with valuvular regurgitation.

Key words: Echocardiography, Geriatric dog, Myxomatous mitral valve disease.

INTRODUCTION

Aging is an intrinsic systemic process that causes a progressive reduction in the ability of an individual to maintain homeostasis inspite of various stresses, resulting in an increasing susceptibility to a disease process (Boari and Ante, 2003). Ageing affects all cells, tissues and organs of the body resulting in altered homeostasis, decreased ability to respond to environmental stimuli, increased frailty, and predisposition for illness. Therefore geriatric populations are at increased risk for the development of systemic abnormalities including multiple organ abnormalities as well as a population more commonly receiving long-term or multiple medications, as alterations in the cardiovascular, respiratory, hepatobiliary and renal systems affects the absorption, distribution and elimination of drugs (Fortney, 2004). Age related cardiovascular diseases include myxomatous valvular disease, dilated cardiomyopathy, neoplasia and sick sinus syndrome (Guglielmini, 2003). Diseases of heart or cardiovascular system represents a major component of geriatric medicine.

MATERIALS AND METHODS

The clinical cases for the present study was selected from a total of 1695 geriatric dogs that were presented to university veterinary clinical complex and various other clinics in Hyderabad, Telangana state during 2013 to 2016. Among the total cases, small breed dogs that were above 9 years and those free from any other systemic disease were selected. Almost all these geriatric dogs were presented with similar history and signs of exercise intolerance, poor physical activity, respiratory distress and cough. Selected cases were evaluated clinically and later subjected for physical examination, chest x-ray and echocardiography. Mitral valve abnormalities and cardiac evaluation was done by 2-d echocardiography using *Ixos vet* and *GE logiq* Doppler machine with micro convex and C6 cardiac probe for confirmative diagnosis of myxomatous mitral valve disease (MMVD).

Transthoracic echocardiograms were obtained with the unsedated dogs in right lateral recumbency. Access to the right side of the thorax was facilitated by use of a table with a special cut-out to allow the transducer to be directed upward towards the site of maximal cardiac pulsation (Allworth *et al.,* 1995). Transducer is located parasternally between right third and sixth intercostal spaces between

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sternum and costochondral junction (Thomas *et al.,* 1994). M-mode recordings were taken at the high papillary level. Measurement of left ventricular dimension at end-diastole (LVEdD) and end-systole (LVEsD) was made intraluminally from the trailing edge of the septal wall image to the leading edge of the ventricular free wall. End-diastolic and end-systolic measurements of the thickness of the Inter Ventricular Septum (IVSd, IVSs) and left Ventricular Posterior Wall (LVPWd, LVPWs) were made using trailing edge (AllWorth *et al.,* 1995). Further, pulsed wave Doppler and colour flow Doppler was also done to assess the mitral valve insufficiency and regurgitation as per the technique suggested by Dominique and Marc-Andre (2008).

RESULTS AND DISCUSSION

Clinical signs

Out of the total geriatric dogs that were presented, 695 small sized dogs of various breed and gender were selected that presented with similar history and manifestations *viz*., exercise intolerance, poor physical activity, reduced playfulness, respiratory distress and cough. Detailed examination further revealed dyspnoea, particularly even at rest, open mouth breathing with dilated nares and exopthalmus and protruding tongue (cyanotic in few occasions) and lethargy. Cough was reported to be nocturnal, predominantly during late night to early morning, where the dog suddenly wakes up with cough and goes breathless for few seconds before becoming normal, in some cases induced by physical activity. About 30 per cent of presented dogs were also reported as insomniac, were completely standing to sitting on hind legs for short periods, without sleep for more than 24-36 hrs. After going through the complete diagnostic protocol, 427 out of 695 geriatric dogs (61.43%) were confirmed for myxomatous valvular disease.

Decreased blood flow, decreased arterial compliance, decreased responsiveness to beta-adrenergic stimulation and increased ventricular stiffness are common age-related changes in the canine cardiovascular system of geriatric dogs (Haidet, 1992 and 1993). Among the various cardiac diseases affecting geriatric dogs, myxomatous mitral valve disease (MVD) is the most common and an important cause of heart failure in dogs (Borgarelli and Buchanan, 2012). Myxomatous mitral valve disease, also termed as chronic valve disease, degenerative valve disease and endocardiosis is a chronic myxomatous degeneration of mitral valve primarily resulting in incomplete coaptation of the leaflets and valvular regurgitation, which accounts for 75-80% of cardiac diseases in dogs (Haggstrom *et al.,* 2005; Borgarelli *et al.,* 2008). With the advancement of age in small breed dogs, the prevalence of MMVD increases gradually and may show the evidence of valve lesions of varied intensity by the time they reach geriatric (Buchanan, 1977 and Borgarelli *et al.,* 2008). Valvular endocardiosis is a chronic degenerative disease affecting most commonly the mitral valve and the compensatory response gradually leads to peripheral arterial vasoconstriction and increased preload that ends up in a clinical entity. The most common clinical signs associated are nocturnal cough, exercise intolerance, dyspnoea and syncope associated with left main stem bronchus compression and pulmonary edema. A series of progressive pathophysiological events may lead to an increase in end-diastolic volume, thereby increase myocardial stress, thinning of the myocardium and rounded left ventricle apex contribute to the development of the clinical manifestation of the disease (Domanjko, 2015). The clinical manifestations recorded in the present study are in accordance with Turgut *et al.* (2017) and Saunders (2012). Coughing which is predominant in these cases might be a result of pressure on the left mainstem bronchus caused by left atrial enlargement (Bright and Mears, 1997), rather than a result of pulmonary edema (Carr, 2004). Lethargy and reduced physical activity could be due to diminished oxygen delivery to the tissues associated with reduced cardiac output (Freeman, 2012). Hypostastic congestion of lungs and pulmonary edema lead to dyspnoea at rest (Ristic, 2004).

Physical examination and radio graphy

Physical examination of valvular disease geriatric dogs revealed murmur of varied intensity *i.e*., from grade II to IV pansystolic murmur, when auscultated at the mitral valve area on left side of the thorax. Dilatation of left atrium or left atrial/auricle bulge, elevation of trachea and pulmonary congestion with a mean vertebral heart score (VHS) 12.2, were the significant radiographic abnormalities of valvular disease geriatric patients (Fig 1). The systolic murmur on auscultation is a hallmark of the valvular disease, where the intensity varies with severity of disease and can be a significant among aged dogs. Presence of S3 sound with an increased intensity of S1 and decreased of S2 sound on left cardiac area are significant physical findings of MMVD (Hägström *et al*., 1995). Radiographic assessment of cardiac size is another important guide to diagnose cardiac disease which also be used to monitor the severity of disease (Hamlin, 1999 and Thrall, 2007), though it is difficult to make

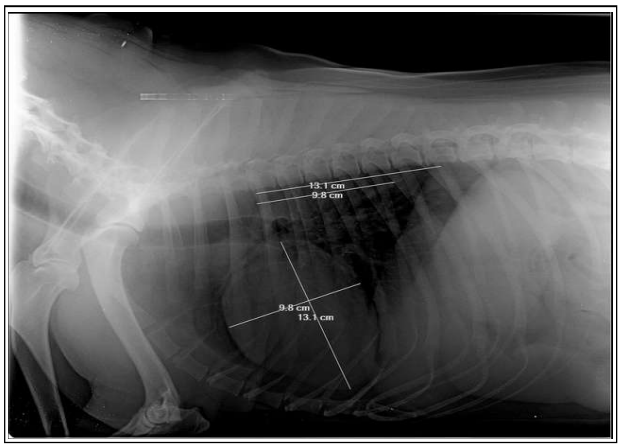


Fig 1: Left lateral exposure of 11yr Cocker spaniel, showing auricular bulge, elevated trachea and pulmonary congestion.

accurate subjective assessment whether the cardiac silhouette is enlarged or misshapen (Boswood, 2010). However, thoracic radiography is considered the clinical ‘‘gold standard’’ method for the diagnosis of heart failure (Balbarini *et al.,* 1991). Radiographically estimated vertebral heart score of more than 12 along with plasma NT pro-BNP (>1500 pmol/L) are the significant aspects of threatened heart failure among chronic mitral valve diseased dogs (Bonagura and Schober, 2009).

Echocardiography

2-dimensional echocardiographic findings of degenerative mitral valve disease geriatric dogs include, hyperechoeic mitral valve leaflets, kinking and prolapse of anterior or posterior or bileaflets above the annular plane, mitral flail and billowing. Some were showing opening of valves in a summated fashion, losing its classic M shape or delayed end diastolic closure pattern giving a “shelf” between the maximal atrial contraction phase and the point of cooptation. Diastolic high frequency oscillations of the anterior mitral valve leaflet, reduced (e-f) slope and thickened valve leaflets, resulting in multiple echoes from each leaflet.Further, echocardiography also revealed the left atrium and ventricle enlargement, hyperkinesis or hyperactivity of interventricular septum, the severity of regurgitation and mitral valve degeneration and rupture of chordae tendineae and pulmonary hypertension (Fig 2-11). Significant findings also include, dilatation of left atrium (2.10±1.28 cm) that was measured by left atrium and aorta ratio and dilated left ventricular end diastolic (56.58±2.87 mm) and end systolic diameter (41.50±1.86 mm) with increased fractional shortening (48.80±2.40 mm), as shown in the Table 1.

Though, clinical and physical examination, thoracic radiography, electrocardiography, echocardiography and cardiac biomarkers are available diagnostic tools (Nakayama *et al.,* 2001), non invasive techniques like radiography and echocardiography are the most common diagnostic procedures used in confirming the heart disease

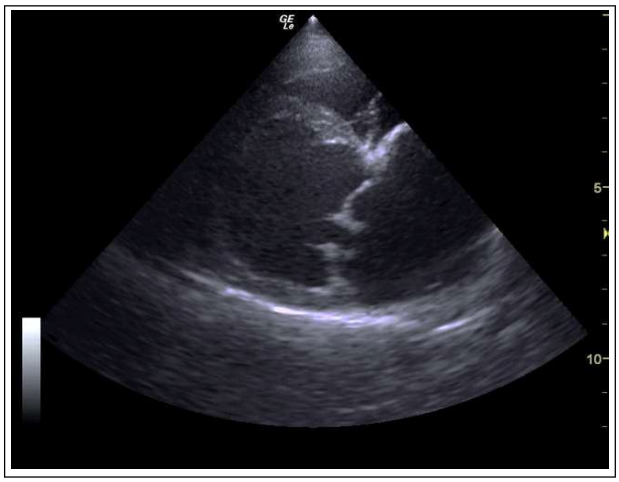


Fig 3: Prolapse of bileaflets with rupture of chordate tendineae, flial and billowing of MV in a 11 year old Beagle.

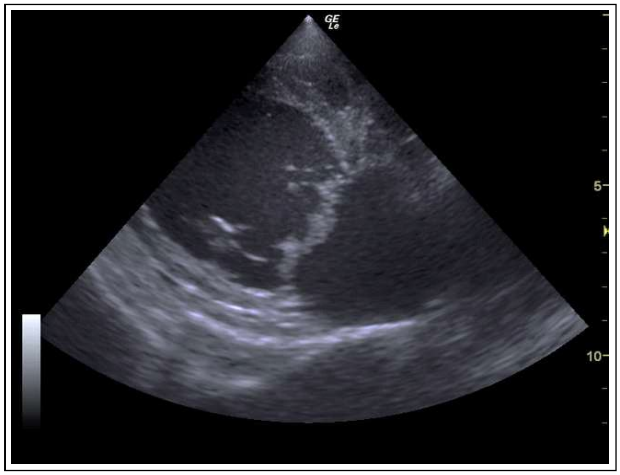


Fig 4: B-mode long axis echo tracing of 11 y Lhasa Apso at MV level: Showing prolapse of bileaflets that are going above the annular plane.

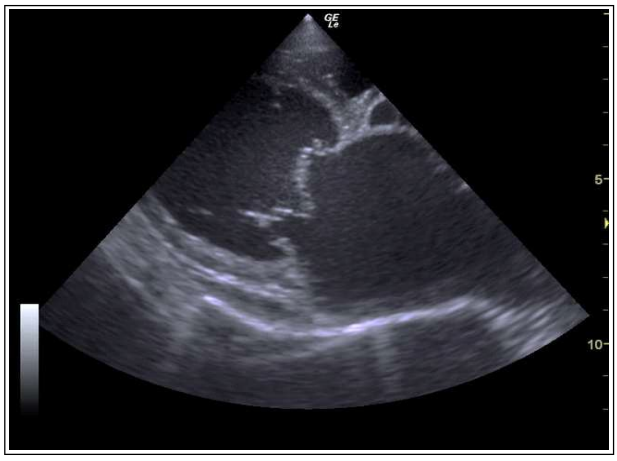


Fig 2: B-mode long axis echo tracing of 9 yr Cocker spaniel, showing prolapse of anterior MV leaflet (P) with rupture of chordate tendineae. Also note dilated LA.

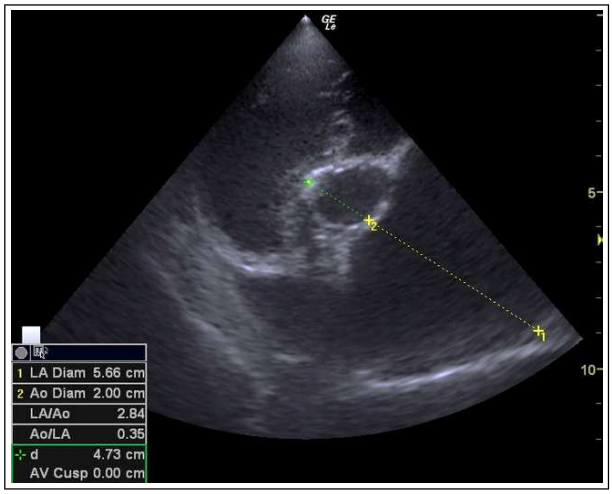


Fig 5: B-mode short axis echo tracing of 10 y Pom, showing dilated left atrium (LA), resulting in increased LA/AO ratio.

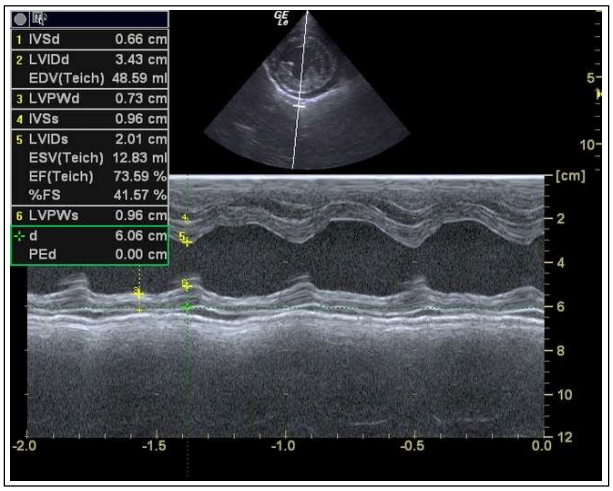


Fig 6: M-mode echo tracing of 12y miniature showing left ventricle dimensions. Note hyperkinetic IVS resulting in increased LVEdD.

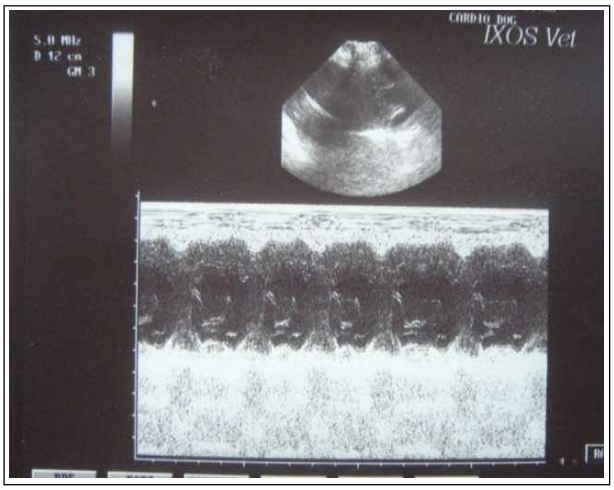


Fig 9: M-mode echo tracing of 10y Pomeranian, showing thickened MV leaflets - evident at the peak of mitral opening and mid diastole.

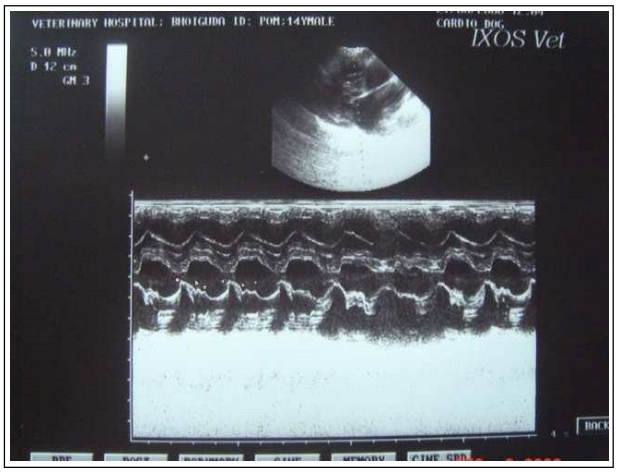


Fig 7: Delayed end diastolic closure pattern of MV, with a "shelf" (b) between maximal atrial contraction opening phase (a) and the point of cooptation (c).

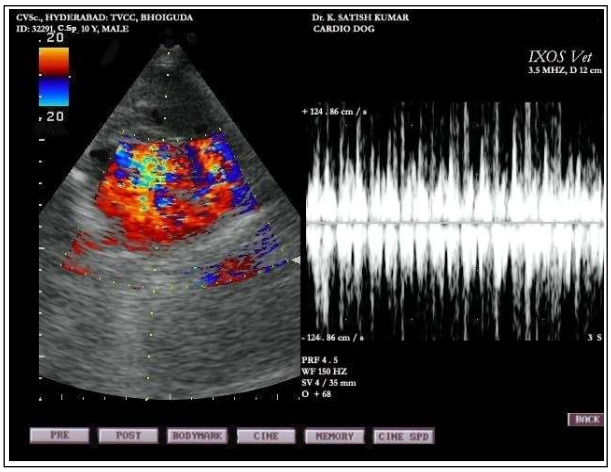


Fig 10: Doppler tracing of 10y Daschund with MMVD. Turbulent jet flow pattern with more than 120 cm of blood flow volume at the mitral valve. Also note mosaic pattern occupying 60% of the LA.

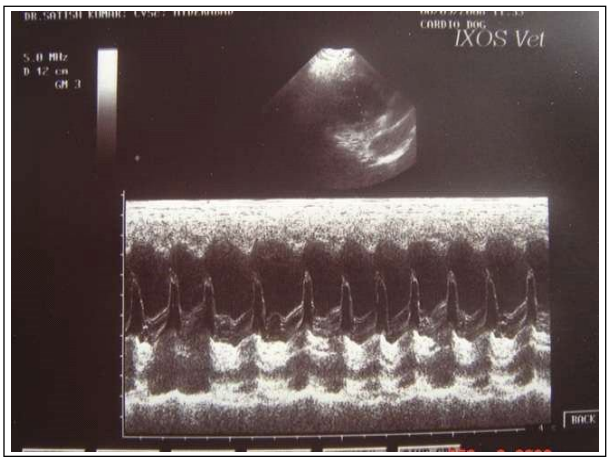


Fig 8: M-mode echo image of 11y miniature, with thick MV leaflets resulting in multiple echoes from each leaflet. Also notice reduced (e-f) slope from impediment of ventricular inflow.

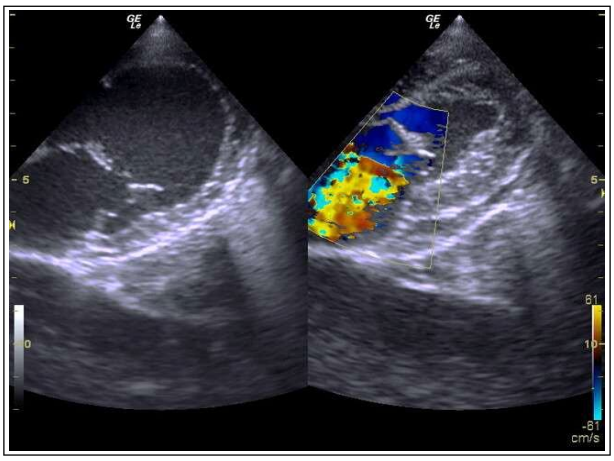


Fig 11: Colour Doppler tracing of 12y Beagle, showing typical mosaic pattern of entire left atrium at end systole.

Table 1: Mean±SE of left ventricle dimensions in apparently healthy adult and MMVD dogs.

Parameter	Apparently healthy adult dogs	MMVD dogs
LVIDd (mm)	35.12±0.58	56.58±2.87*
LVIDs (mm)	29.22±0.36	41.50±1.86*
LVPWd (mm)	6.10±0.32	6.86±0.68
LVPWs (mm)	9.02±0.30	8.60±0.34
IVSd (mm)	4.72±0.42	5.50±0.50
IVSs (mm)	6.02±0.11	6.86±0.85
EPSS (mm)	4.13±0.10	6.08±1.39*
EF (%)	58.28±1.34	71.30±1.79*
FS(%)	30.12±0.26	48.80±2.40*
LA/AO	1.12±0.21	2.10±1.28*

*Significant at (P<0.05).

in dogs (Detweiler *et al.*, 1961). Echocardiography is the more sensitive means that confirms the prolapsed valve, enlarged chamber, severity of regurgitation and valve degeneration. Echocardiographic and radiographic changes also help to identify the animals at increased risk of heart failure or death from valvular disease (Hezzell *et al.,* 2012). Among the various echocardiographic features, mitral valve prolapse is a common finding in dogs with myxomatous valve degeneration (Sargent *et al.,* 2015). Degradation of the collagen weave between cardiomyocytes lead to progressive degeneration of mitral valve, dilatation of atrio-ventricular annulus resulting in the regurgitation of mitral valve (Domanjko, 2015). As the disease progresses, there is proliferation of various layers like, endothelium and spongiosa with increased fibroblast resulting in thickened spongiosa with mesenchymal tissue appearance, thus referred as myxomatous (Kittleson, 2005). It also causes thickening of sub-endothelial layer (Hadian *et al.,* 2010). These changes collectively leads to the prevention of effective coaptation, resulting in valvular regurgitation, increased cardiac work that ends up with ventricular dysfunction associated with eccentric hypertrophy of both atrium and ventricle.

Left atrium to aorta ratio (LA/Ao) and left ventricle end diastolic diameter are the significant echocardiographic measures that independently predict the risk of heart failure in these cases (Reynolds *et al.,* 2012). Dilatation of left ventricular end diameter at diastole, with normal left ventricular end diameter at systole initially, but dilatation in the chronic degenerative mitral valve disease in later stages are usually seen in MMVD dogs, resulting in an increased fractional shortening (over 50%) which comes to normal with advanced disease process (Reynolds *et al.,* 2012). Systolic function is difficult to assess in MMVD due to the enhanced sympathetic tone (Bonagura and Schober, 2009). Though, mitral valve prolapse, is considered as one of the important predisposition factors for MMVD, other stress factors like physical and physiological stress also contribute to the disease. The thickening of the valve leaflets is also associated with stress induced endothelial dysfunction (Pedersen *et al*., 1999). Decreased levels of serum serotonin concentrations is one of the recent developments in the diagnosis of degenerative mitral valve disease (Ljungvall *et al.,* 2013).

CONCLUSION

As the age advances and the dog reaches geriatric, alterations in the cardiovascular, respiratory, hepatobiliary and renal systems leads to an increased risk for the development of systemic abnormalities including multiple organ dysfunctions. In the present study, MMVD was diagnosed in 65% of geriatric small sized breed. Thickening, prolapsed, flial appearance, rupture of chordae tendineae, increased left ventricular end diastolic and systolic dimensions along with increased shortened fraction were the significant echocardiographic features among present study.

Conflict of interest

There is no conflict of interest among the authors.

REFERENCES

Allworth, S.M., Church, D.B., Maddison, J.E., Einstein, R., Brennar, P., Anssein, N.A. and Mathews, R. (1995). Effect of enalapril in dogs with pacing induced heart failure. American Journal of Veterinary Research. 56: 86-94.

Balbarini, A., Limbruno, U., Bertoli, D., Tartarini, G. and Baglini, R. (1991). Evaluation of pulmonary vascular pressures in cardiacpatients: The role of the chestroentgenogram. Journal of Thorac Imaging. 6: 62-68.

Boari, A. and Aste, G. (2003). Diagnosis and management of geriatric canine endocrine disorders. Veterinary Research Communication. 27(1): 543-554.

Bonagura, J.D. and Schober, K.E. (2009). Can ventricular function be assessed by echocardiography in chroniccanine mitral valve disease? Journal of Small Animal Practice. 50(1): 12-24.

Borgarelli, M. and Buchanan, J.W. (2012). Historical review, epidemiology and natural history of degenerative mitral valve disease. Journal of Veterinary Cardiology. 14: 93-101.

Borgarelli, M., Savarino, P., Crosara, S., Santilli, R.A. and Chiavegato, D. (2008). Survival characteristics and prognostic variables of dogs with mitral regurgitation attributableto myxomatous valve disease. Journal of Veterinary Internal Medicine. 22(1): 120-128.

Boswood, A. (2010). Current use of pimobendanin canine patients with heart disease. Veterinary Clinics. North American Small Animal Practice. 40(4): 571-80.

Bright, J.M. and Mears, E. (1997). Chronic heart disease and its management. Veterinary Clinics. North American Small Animal Practice. 27(6): 1305-1329.

Buchanan, J.W. (1977). Chronic valvular disease (endocardiosis) in dogs. Advances in Veterinary Science and Comparative Medicine. 21: 75-106.

Carr, A.P. (2004). Cardiac disease in geriatric dogs and cats. In Geriatrics and Gerontology of the Dog and Cat. WB Saunders. pp. 127-148

Detweiler, D.K., Patterson, D.F., Hubben, K. and Botts, R.P. (1961). The prevalence of spontaneously occurring cardio vascular disease in dogs. American Journal of Public Health. 51(2): 228-241.

Domanjko Petrič, A. (2015). Myxomatous mitral valve disease In dogs - an update and perspectives. Mac. Vet. Rev. 38(1): 13-20.

Dominique Pennique and Marc-Andre d' Anjou. (2008). Atlas of small Animal Ultrasonography, I edn., Blackwell Publishing, Australia.

Dove, R.S. (2001). nutritional therapy in the treatment of heart disease in dogs. Alternatives of Medical Review. 6: 38-45.

Fortney, W.D. (2004). Geriatrics and Aging, In: Geriatrics and Gerontology of Dog and Cat by Johnny D.H, 2nd edition, Saunders. 1-4.

Freeman, L.M. (2012). Cachexia and sarcopenia: Emerging syndromes of importance in dogs and cats. Journal of Veterinary Internal Medicine. 26: 3-17.

Guglielmini, C. (2003). Cardiovascular diseases in the ageing dog: diagnostic and therapeutic problems. Veterinary Research Communication. 27(1): 555-560.

Hadian, M., Corcoran, B.M. and Bradshaw, J.P. (2010). Molecular changes in fibrillarcollagen in myxomatous mitral valve disease. Cardiovascular Pathology. 19: 141-148.

Haggstrom, J., Kvart, C. and Pedersen, H.D. (2005). Acquired Valvular Disease. In: Textbook of Veterinary Internal Medicine, [Ettinger, S.J., Feldman, E.C., (edn)]., 6th edn., Elsevier, St Louis. Pp. 1022-1039.

Hägström, J., Kvart, C. and Hansson, K. (1995). Heartsounds and Murmurs: Changes related to severity ofchronic valvular disease in the Cavalier King Charles Spaniel. Journal of Veterinary Internal Medicine. 9: 75-85.

Haidet, G.C. (1992). Effect of age on cardiovascular responses to static muscular contraction in beagles. Journal of Applied Physiology. 73: 2320-2327.

Haidet, G.C. (1993). Effects of age on beta-adrenergic-mediated reflex responses to induced muscular contraction in beagles. Mechanisms of ageing and Development. 68: 89-104.

Hamlin, R.L. (1999). Pathophysiology of the Failing Heart. In: Textbook of Canine and Feline Cardiology, [Fox, P.R., Sisson, D. and Moise, N.S. (edn.)]: WB Saunders Co. Philadelphia. Pp. 205-215.

Hezzell, M.J., Boswood, A., Moonarmart, W. and Elliott, J. (2012). Selected echocardiographicvariables change more rapidly in dogs that die from myxomatousmitral valve disease. Journal of Veterinary Cardiology. 14: 269-279.

Kittleson, M.D. (2005). Myxomatous mitral valvedisease. In: Small Animal Cardiovascular Medicine. (Kittleson, M.D. and Kienle R.D). St. Louis, Mosby.

Ljungvall, I., Höglund, K., Lilliehöök, I., Oyama, M.A., Tidholm, A., Tvedten, H. and Hägström, J. (2013). Serumserotonin concentration is associated with severityof myxomatous mitral valve disease in dogs. Journal of Veterinary Internal Medicine. 27: 1105-1112.

Nakayama, H., Nakayama, T. and Hamlinxya, R.L. (2001). Correlation of cardiacenlargement as assessed by vertebral heartsize and echocardiographic and electrocardiographic findings in dogs with evolving cardiomegaly due to rapid ventricular pacing. Journal of Veterinary Internal Medicine. 15(3): 217-221.

Pedersen, H.D, Lorentzen, K.A. and Kristensen, B.Ø. (1999). Echocardiographic mitral valve prolapse in Cavalier King Charles Spaniels: Epidemiology andprognostic significance for regurgitation. Veterinary Record. 144: 315-320.

Reynolds, C.A., Brown, D.C., Rush, J.E., Fox, P.R., Nguyenba, T.P., Lehmkuhl, L.B., Gordon, S.G., Kellihan, H.B., Stepien, R.L, Lefbom, B.K., Meier, C.K. and Oyama, M.A. (2012). Prediction of first onsetof congestive heart failure in dogs with degenerativemitral valve disease: The Predict cohort study. Journal of Veterinary Cardiology. 14(1): 193-202.

Ristic, J. (2004). Clinical assessment of the dog with suspected cardiac disease. In Practice. 26: 192-199.

Sargent, J., Connolly, D.J. and Watts, V. (2015). Assessment of mitral regurgitation in dogs: Comparison of results of echocardiography with magnetic resonance imaging. Journal of Small Animal Practice. 56: 641-650.

Saunders, A.B. (2012). The diagnosis and management of age-related veterinary cardiovascular disease. Veterinary Clinics Small Animal Practice. 42: 655-668.

Thomas, P.W., Gaber, C.E., Jacobs, G.J., Kaplan, P.M., Lombard, C.W., Moise, N.S. and Moses, B.L. (1994). Recommendations for standards in transthoracic two-dimensional echocardio -graphy in the dog and cat. Veterinary Radiology and Ultrasound. 35: 173-178.

Thrall, D.E. (2007). Veterinary Radiology. 5th edn., Philadelphia, Saunders Elsevier. pp. 479-485.

Turgut, K. (2017). Klinik Kedi ve Köpek Kardiyolojisi. Nobel Tıp Kitabevleri Tic. Ltd. Şti., İstanbul.