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Cardiac Arrhythmias in Dogs with Mitral Regurgitation due to Myxomatous Mitral Valve Disease

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Summary: Cardiac remodeling in dogs with mitral regurgitation (MR) may stimulate several supraventricular arrhythmias. The purpose of this study was to point out the potential of cardiac arrhythmias related to remodeling in dogs with MR. The study was carried out in 30 client-owned dogs with the signs of myxomatous mitral valve disease (MMVD). Routine clinical applications including cardiac examination, blood analyses and imaging procedures were performed. The inclusion criterion was the presence of left apical heart murmur. While group 1 (n:10) was defined as mild MR with regurgitant jet occupying less than 20% of the left atrial area, group 2 (n:10) was defined as moderate MR with regurgitant jet occupying between 20-40% of the left atrial area. Group 3 (n:10) was also defined as severe MR with regurgitant jet occupying more than 40% of the left atrial area. ECG variables were recorded by a 6-lead ECG machine. Arrhythmias in dogs with MMVD included Sinus Tachycardia (n:11, 37%), Sinus Arrhythmia (n:10, 33%), Supraventricular Premature Complex (n:4, 13%), Atrial Fibrillation (n:4, 13%), Tachycardia-Bradycardia Syndrome (n:2, 6%), 2nd Degree Atrioventricular Block (n:2, 6%), Left Bundle Branch Block (n:1, 3%) and Sinus Pause (n:1, 3%). No significant association were found between the presence of cardiac arrhythmias and the severity of MR groups ($p>0.05$). In conclusion, cardiac remodeling in dogs with MR can induce several supraventricular arrhythmias. Although we could not find significant correlations between the presence of cardiac arrhythmias and the severity of MR groups, further studies with larger case series are required.
Key words: Arrhythmia, dog, heart, mitral regurgitation

Miksömatöz Mitral Kapak Hastalığı Nedenli Mitral Regürgitasyonu Bulunan Köpeklerde Kardiyak Aritmiler

Özet: Mitral regürgitasyonlu (MR) köpeklerde kardiyak remodeling bir çok supraventriküler aritmiyi stimüle edebilmektedir. Bu çalışmanın amacı, MR'li köpeklerde kardiyak remodelingle ilişkili aritmi potansiyeline dikkat çekmektir. Çalışma miksömatöz mitral kapak hastalığı (MMVD) belirtilerini taşıyan sahipli 30 köpekle yapıldı. Kardiyak muayene, kan analizleri ve görüntüleme prosedürlerini kapsayan rutin klinik uygulamalar gerçekleştirildi. Çalışmaya sol apikal kalp üfürümü olan hastalar dahil edildi. Regürgitant akımın sol atriumun % 20'sinden daha az alan kapladığı hafif şiddetli MR'li hastalar grup 1'e (n:10) dahil edilirken; regürgitant akımın sol atriumun % 20-40'ını kaplayan orta şiddetli MR'li hastalar ise grup 2'ye (n:10) alındı. Regürgitant akımın sol atriumun % 40'ından daha fazla alan kapladığı şiddetli MR'li hastalar ise grup 3'e (n:10) dahil edildi. EKG kayıtları 6 derivasyonlu cihaz ile kaydedildi. MMVD'li köpeklerdeki aritmiler sırasıyla; Sinüs taşikardi (n:11, 37%), sinus aritmi (n:10, 33%), supraventriküler prematüre kompleks (n:4, 13%), atrial fibrilasyon (n:4, 13%), taşikardi-bradikardi sendrom (n:2, 6%), 2. derece atriyoventriküler blok (n:2, 6%), sol dal bloğu (n:1, 3%) ve sinus pause'du (n:1, 3%). Kardiyak aritmilerin frekans dağılımları ile MR'nin şiddeti arasında bir ilişki bulunmadı ($p>0.05$). MR'li köpeklerde kardiyak remodelingin birçok supraventriküler aritmiyi stimüle edebileceği sonucuna varıldı. Her ne kadar kardiyak aritmiler ile MR'nin şiddeti arasında ilişki bulunamadıysa da, bu konuda daha geniş olgu sayılı ileri çalışmalara ihtiyaç vardır.
Anahtar Kelimeler: Aritmi, kalp, köpek, mitral regürgitasyon

Introduction

Mitral regurgitation (MR) attributable to myxomatous mitral valve disease (MVMD) has been reported as the most common acquired heart disease in small breed dogs. Of all heart disease in geriatric dogs, 75% is MMVD-associated problems (1). Because of the progressive myxomatous degeneration of mitral valve, leaflet coaptation and valvular regurgitation occur (7). MR resulting from thickening and abnormal motion of the leaflets enforces a reverse volume changing between the left atrium and left ventricle (3,11). When MR has progressed over years, left atrial structure and function is influenced by valvular

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regurgitant flow which causes to remodeling phenomenon of left atrium and ventricle (4).

Changing in atrioventricular hemodynamic, myocardial hypoxia and progressive neurohormonal disturbances may induce several supraventricular arrhythmias (4,14,17).

The purpose of the current study was to point out the potential of cardiac arrhythmias in dogs with different stages of MR.

Material and Method

Study design

The study was carried out with 30 client-owned dogs referred to Veterinary Teaching Hospital of Ankara University with the signs of myxomatous mitral valve disease (MMVD) including coughing, dyspnea and exercise intolerance. All dogs had antiparasitic therapy and routine vaccination. Routine clinical applications including cardiac examination, blood analyses (CBC, Urea, Creatinine, Glucose, ALP, ALT, AST, Creatine Kinase, Na, K) and imaging procedures (thoracic radiography and echocardiography) were performed in all dogs. The inclusion criterion was the presence of left apical heart murmur in dogs with MMVD. Written owner consent was obtained in the study.

The presence and severity of mitral regurgitation (MR) confirmed by echocardiographic examination (Esaote Biomedica AU5 multi-frequency machine equipped with phrased-array 2-5 MHz transducer) in left apical four chamber view (6). Dogs were divided into three groups according to severity of MR. While group 1 (n: 10) was defined as mild MR with regurgitant jet occupying less than 20% of the left atrial area, group 2 (n: 10) was defined as moderate MR with regurgitant jet occupying between 20-40% of the left atrial area. Group 3 (n: 10) was also defined as severe MR with regurgitant jet occupying more than 40% of the left atrial area. Ratio of left atrium to aortic diameter was also defined in each group of dogs with MR in right parasternal short axis view.

The Electrocardiographic variables were recorded by a 6-lead ECG machine (Carewell® 1106L portable, 50 mm/s,10 mm/mV) for 2 minutes in all dogs lying right lateral recumbency without any sedation procedure. Electrocardiographic variables based on the followings: sinus pause, RR intervals >2.0 seconds; sinus arrhythmia, as a RR interval >180% longer than the previous RR interval (8); sinus tachycardia, >3 sinus complexes at a HR>160 bpm; supraventricular premature complexes, a premature beat with abnormal P wave conducting a normal appearing QRS complex; supraventricular tachycardia and >3 supraventricular complexes at a HR >150 bpm (9).

Dogs were excluded from the study if they had non-cardiac disease on history, clinical exam and blood analyses. Dogs with pulmonary edema on thoracic radiographs were also excluded.

Statistics

Before performing significance testing, Shapiro-Wilk test was used to examine the normal distribution of the data and the Levene test was used to verify the homogeneity of variances as parametric test assumptions. Results of the Shapiro Wilk and Levene test revealed that, only *Left atrium / Aorta (LAAO) variable did not met the parametric test assumptions. To evaluate the difference of LAAO measurements between groups, Kruskal Wallis test was used, followed by multiple Mann Whitney U tests with Bonferroni adjustment using P<0.0167 criteria, as post-hoc procedure. One-way analysis of variance (ANOVA) was used for age, body weight and heart rate variables that provided the parametric test assumptions. For the groups with significant differences, Tukey test was used as a post hoc procedure. Fisher-Freeman-Halton test statistics was used to evaluate frequency distribution of various type of c*ardiac arrhythmias in dogs with different degrees of mitral regurgitation. A p -value less than 0.05 were considered statistically significant. All analyzes were performed using SPSS 14.01 (License No: 9869264) statistical software.

Results

The study consisted of 30 dogs including Cavalier King Charles Spaniel (n: 9), Cairn Terrier (n: 10), Yorkshire Terrier (n:4), Pug (n:2), Pomeranian (n:2), Poodle (n:1), Shih-Tzu (n:1) and Chihuahua (n:1).

Table 1. Characteristics in groups (Mean ± Std. Error of mean)

Groups	Group 1, n: 10 (♂:4, ♀:6) (Mild MR)	Group 2, n: 10 (♂:6, ♀:4) (Moderate MR)	Group 3, n:10 (♂:3, ♀:7) (Severe MR)	P values
Age (years)	11.6±0.79	12.2±0.99	17.3±0.98	P=0.898
BW (kg)	5.7±0.73	6.1±0.6	4.9±0.81	P=0.139
LA/AO (cm)	1.32±0.009 [b]	1.56±0.1 [ab]	2.78±0.27 [a]	P=0.024
HR (bpm)	139±2.48 [b]	155±3.09 [ab]	162.8±3.48 [a]	P=0.036

BW: Body weight, LA: Left atrium, AO: Aorta, HR: Heart rate, bpm: Beat per minute
[a,b]: Values in the same column followed by different superscript letters are statistically different (P<0.05)

The mean age of dogs enrolled in the study were 13.7±5.7. The mean age, body weight, gender and breed distributions in groups were shown in table 1. HR frequency recorded with 2 minute ECG in groups was also shown in table 1.

The most common clinical signs in dogs were exercise intolerance (n: 23, 76%), coughing (n: 19, 63%), tachypnea (n: 16, 53%) and tachycardia (n:14, 46%), respectively.

Of 10 dogs in group 1, 5 (50%) had sinus arrhythmia. Sinus tachycardia (Fig 1) in 4 dogs (40%) and tachycardia-bradycardia syndrome in 1 dog (10%) were remarkable. 2 minute ECG also revealed 2nd degree atrioventricular block (Fig 2) in 1 dog in group 1. In group 2 (n=10), cardiac arrhythmias on 2 minute ECG consisted of sinus arrhythmia (n:4, 40%), sinus tachycardia (n:3, 30%), supraventricular premature (n:1, 10%), 2nd degree atrioventricular block (n:1, 10%) and fine atrial fibrillation (Fig 3) (n:1, 10%). In group 3 (n=10), 2 minute ECG revealed fine atrial fibrillation with a fast ventricular response (n: 3, 30%), sinus tachycardia (n:4, 40%), supraventricular premature complex (n:3 30%), sinus pause (n:1, 10%), left bundle branch block (n:1, 10%), sinus arrhythmia (n:1, 10%) and tachycardia-bradycardia syndrome (n:1, 10%). P-mitrale (n:26, 86%) and P-pulmonale (n:4, 30%) was also recorded in dogs (Table 2).

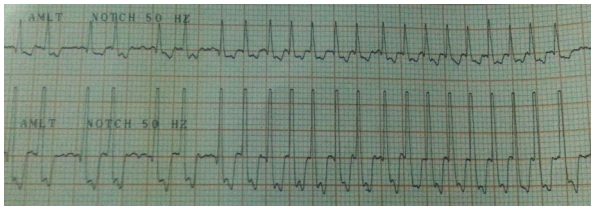

Fig 1. Paroxysmal sinoatrial tachycardia (50 mm/s, 10 mm/mV, lead II)

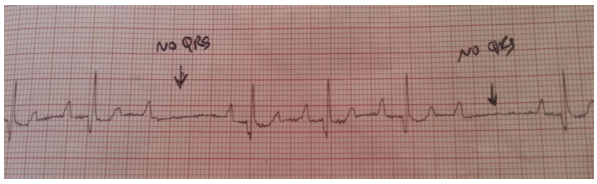

Fig 2. 2nd Degree atrioventricular block (Mobitz type 2). Note the prolonged constant PR interval with intermittent

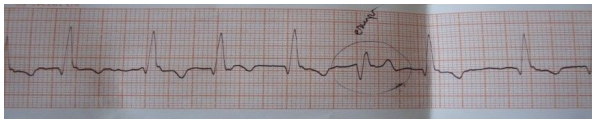

Fig 3. Fine atrial fibrillation with an escape rhythm (50 mm/s, 10 mm/mV, lead II)

depletion of sinoatrial node. Increased myocardial fibrotic tissue, ischemia and infarction of muscle architecture are the other possible reasons of cardiac arrhythmias (13,19). Decrease in cardiac output due to activation of renin-angiotensin-aldosterone system and elevation in cardiac afterload induce general hypoxia in baroreceptors and reflex tachycardia under the command of sinoatrial node. Sinus tachycardia can become early sign of cardiac compensation. In addition, rapid heart rate due to early neurohormonal activation occurs in the beginning stage of the cardiac disease (10). In the current study sinus tachycardia was also the most common cardiac ar-

Table 2. Cardiac arrhythmias in dogs with different degrees of MR

Cardiac Arrhythmias	Group 1, n:10 (Mild MR)	Group 2, n:10 (Moderate MR)	Group 3, n:10 (Severe MR)	n (%)	P-value
Sinus Tachycardia	4	3	4	11 (37)	0.998
Sinus Arrhythmia	5	4	1	10 (33)	0.228
Supraventricular Premature Complex	-	1	3	4 (13)	0.286
Atrial Fibrillation	-	1	3	4 (13)	0.286
Tachycardia-Bradycardia Syndrome	1	-	1	2 (6)	0.999
2nd Degree Atrioventricular Block	1	1	-	2 (6)	0.999
Left Bundle Branch Block	-	-	1	1 (3)	0.999
Sinus Pause	-	-	1	1 (3)	0.999
P-Mitrale (>0.04 s)	9	10	7	26 (86)	0.285
P-Pulmonale (>0.4 mv)	-	1	3	4 (13)	0.286

MR: Mitral regurgitation

In terms of frequency distribution, no significant association were found between the presence of cardiac arrhythmias and the severity of MR in groups (P>0.05) (Table 2).

Discussion and Conclusion

Various cardiac arrhythmias have been reported in dogs with mitral regurgitation (2). Hemodynamic alterations of left atrium due to structural changes lead to dilatation of atrial space, microscopic changes and

rhythmia in dogs with different stages of MR.

Sinus arrhythmia is common in healthy dogs without any clinical significance (13). Sinus arrhythmia results from cardiac vagal function reflecting respiratory-circulatory interactions (14). It is also possible to observe sinus arrhythmia in dogs with MR [5]. In this study, sinus arrhythmia observed in one third of dogs.

It is possible to see atrial premature beats in dogs with various structural and hemodynamic alterations of atriums (15,16). Atrial enlargement and myocardial hypoxia associated with mitral regurgitation induce to premature beats. Any alterations in myocardial oxygenation capacity can lead early repolarization causing to more malignant arrhythmias (12). In the present study atrial premature beats documented in dogs had mentioned pathogenic mechanisms.

In dogs with chronic MR, atrial fibrillation (AF) associated with chronic left atrial dilatation may be observed (18). Previous studies have supported the idea that left atrial posterior wall may play a role in the mechanism of AF induced by chronic left atrial dilatation (16,18). However in 53% of dogs with chronic MR, sustained AF was apparent (2). In this study, AF in 4 dogs was documented. No observed AF in group 1 could explain the role of chronicity-induced mechanism of AF.

Fibrosis or ischemia of atrioventricular node is common cause of atrioventricular blocks in dogs. Coronary arterial disease also triggers declining of myocardial contractility when it was present in dogs with MR (5). However in this study, it was thought that atrioventricular blocks in 2 dogs with MR were associated with spontaneous disorder of atrioventricular node or remodeling of ventricles. We could not specified clinical correlation between MR severity and atrioventricular block in the study.

In conclusion, cardiac remodeling in dogs with MR can induce several supraventricular arrhythmias. Although we could not find significant correlations between the presence of cardiac arrhythmias and the severity of MR in groups, further studies with larger case series are required. Diagnosis of cardiac arrhythmias in dogs with MR could help to manage of unwanted results.

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