EVALUATION OF CARDIAC FUNCTION IN HYPOTHYROID DOGS USING ELECTRO-CARDIOGRAHY AND ECHOCARDIOGRAPHY

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Abstract

The present study was carried out to evaluate cardiac function in hypothyroid dogs. Hypothyroidism was diagnosed in 12 dogs based on clinical signs, normal or low serum triiodothyronine (T_3), low tetraiodothyroxine (T_4) beyond the reference range. The electrocardiographic changes noted were reduced PR interval, sinus arrhythmia, ventricular premature complex and low R wave amplitude in hypothyroid dogs. The major echocardiographic findings were increased interventricular septum thickness at end diastole, posterior wall thickness at end diastole and end systole. Mitral valvular insufficiency was diagnosed in five out of twelve cases on colour doppler study. The electrocardiography and echocardiography was done again on 30th day of treatment with oral levothyroxine. Electrocardiography revealed persistence of low amplitude R wave and sinus arrhythmia. The echocardiographic parameters such as left ventricular internal diameter at diastole, end diastolic volume, stroke volume and cardiac output were lowered after one month of treatment.

Key words: *Hypothyroidism, Electrocardiography, Echocardiography, Mitral valvular insufficiency*

Hypothyroidism is an endocrine disorder that arises as a consequence of decreased activity of thyroid hormones at tissue level. It is the most common endocrinopathy treated by small animal veterinary practitioners. Thyroid hormone being essential for metabolic activities of each and every organ, this disease may have different clinical presentations. According to Dillmann (1990), triiodothyronine (T_3) concentration produces positive inotropic and chronotropic effects on the myocardium through its nuclear as well as extranuclear action. Decreased tetraiodothyroxine (T_4) levels have been sparingly reported in association with canine cardiovascular system disorders.

Hypothyroidism is considered as a cause for reduction of myocardial contractility from some clinical case studies in dogs. Early detection and treatment of cardiovascular

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disease in hypothyroid dogs may be beneficial in managing the further progression of condition. So the present study was carried out with the objective of assessing cardiac function in hypothyroid dogs using the diagnostic tools of electrocardiography and echocardiography.

Materials and Methods

The dogs presented to the University Veterinary Hospital, Mannuthy and Kokkalai with symptoms resembling that of hypothyroidism were screened by estimating serum T_3 and T_4 by Chemiluminiscent microparticle immunoassay. In the present study, 12 dogs were diagnosed based on symptoms of hypothyroidism, lowered or normal serum T_3 (<48 ng/dl) and lowered T_4 (<1.5 µg/dl). Before initiating treatment, hypothyroid dogs were subjected to electrocardiographic and echocardiographic studies. Electrocardiographic and echocardiographic evaluation was also done in six apparently healthy dogs. For the comparative study, 12 hypothyroid dogs were assigned as group I and six apparently healthy dogs as group II. Treatment for hypothyroidism was initiated with levothyroxine at a dose rate of 20 µg/kg bodyweight orally once daily on empty stomach as per Dixon *et al*. (2002) and Karlapudi *et al.* (2012). Cardiac medication was also added to treatment regimen in those dogs with cardiac dysfunction. Electrocardiography and echocardiography were also carried out after treatment period of one month. Dosage adjustments of levothyroxine were done according to thyroid hormonal status after one month. The statistical comparison of electrocardiographic and echocardiographic parameters of hypothyroid dogs with that of apparently healthy dogs were done using independent sample t-test whereas the comparison of the same parameters of hypothyroid dogs on 0^{th} day and 30^{th} day of treatment was done via paired sample t-test using IBM Statistical package for Social Sciences (SPSS), Version 24.0.

Results and discussion

Serum thyroid hormones: The mean serum T_3 concentration in group I dogs on the day of screening was significantly lower (45.89±4.18 ng/dl) than group II dogs (80.03±7.33 ng/dl). The mean serum T_4 concentration of hypothyroid dogs on the day of screening (0.98±0.053 µg/dl) was significantly lower (P<0.01) than group II dogs 2.49±0.01 µg/dl. This finding was similar to the finding of Gomathy *et al.* (2004) who reported mean T_3 and T_4 concentration in hypothyroid dogs as 0.45±0.06 ng/ml and 1.28 ±0.06 µg/dl respectively.

***Electrocardiographic measurements and changes observed*:** Electrocardiographic parameters such as heart rate, P wave amplitude, PR interval, R wave amplitude, P wave duration, Q duration, QT interval and T wave amplitude of group I dogs on 0^{th} day and on 30^{th} day of treatment were statistically analyzed. The above measurements of group I were also compared with that of group II dogs. There was no statistically significant difference between the values of group I dogs on 0^{th} and 30^{th} day of treatment. On comparison with group II dogs, PR interval of group I dogs on 0^{th} day of treatment (0.105 ± 0.006 seconds) was significantly reduced (P<0.05) than that of group II (0.12 ± 0.003 seconds). The heart rate of group I animals 0^{th}day of treatment was higher (117.25 ± 4.55 bpm) than group II dogs (115.50±9.31bpm) and this might be the reason for reduced PR interval of group I dogs on 0^{th} day of treatment as PR interval is inversely proportional to heart rate (Cote, 2010). Sinus arrhythmia was observed in three cases which

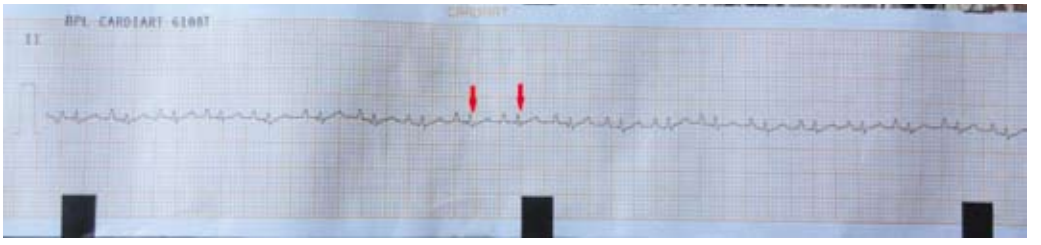

Fig.1 Low amplitude R wave on bipolar limb lead II

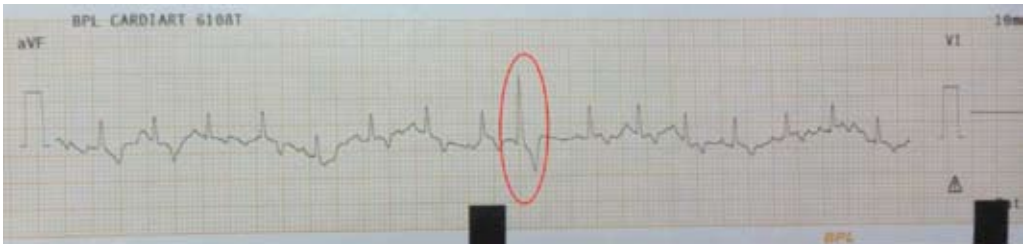

Fig. 2 Ventricular premature complex in AVF lead

was in agreement to Kienle *et al.* (1994). Low amplitude R waves (< 0.5 mv) were observed in two cases (Fig.1) as observed by Ferguson (1994), Kienle *et al.* (1994), Stephan *et al.* (2003), Flood and Hoover (2009) and Karlapudi *et al.* (2012). Occasional ventricular premature complex (VPC) was observed in a case with severe mitral regurgitation (Fig 2). Flood and Hoover (2009) and Karlapudi *et al.* (2012) also reported ventricular premature complexes in hypothyroid dogs.

Electrocardiogarphy on 30th day of treatment revealed the following observation. Sinus arrhythmia noticed on 0th day of treatment was absent in two cases but in one case it was persistant. No significant increase in amplitude of R wave was observed in two cases where there was low amplitude R wave on 0th day. Ventricular premature complex was absent in the ECG of dog with occasional VPC in ECG on 0thday of treatment.

Fig. 3 Thickened mitral valve and chordae tendinae in a dog on Right parasternal long axis left ventricular outflow view

Fig. 4 Mosaic pattern across mitral valve using colour flow doppler on left apical view

Echocardiographic findings: Screening of hypothyroid dogs for cardiac disease showed that 5 out of 12 *i.e* 41.67 per cent of them had mitral valvular insufficiency with thickening of mitral valvular leaflets in B mode echocardiography (Fig.3) and regurgitant jet with mosaic colour pattern across the mitral valve (Fig. 4) on colour flow doppler study (Olsen *et al.* 2010). Two dogs with mitral valvular insufficiency were aged four, two dogs were 7-8 years of age and one dog was 10 years of age. This was in agreement to the finding of low thyroxine levels by James (2011) and Unny (2014) in dogs with mitral valvular insufficiency.

Colour Doppler studies on 30th day of treatment revealed that, regurgitant jet across the mitral value with mosaic colour pattern was still present in five cases with mitral valvular insufficiency without any appreciable increase in severity.

Echocardiographic measurements: The B mode measurement of left atrial aortic root ratio of group I dogs on 0th and 30th day of treatment were 1.03 ± 0.04 and 1.07 ± 0.04 respectively which was not statistically different from values of group II dogs. This value of group I dogs on 0th and 30th day of treatment were also not statistically different from each other. Left atrial aortic ratio is used to measure left atrial enlargement which could be elevated in severe cases of hypothyroidism as reported by Flood and Hoover (2009) and in cases of dilated cardiomyopathy with hypothyroidism

(Karlapudi *et al.*, 2012). In the present study, left atrial enlargement or dilated cardiomyopathy was not diagnosed in any of the hypothyroid dogs.

The M mode echocardiographic measurements such as interventricular septum thickness at end systole, left ventricular internal diameter at end systole, end systolic volume, ejection fraction and fractional shortening of group I dogs on 0th day of treatment and 30th day of treatment were not statistically different from that of group II dogs. The mean interventricular septum thickness at end diastole of group I dogs on 0th day (10.75± 0.35 mm) and 30th day of treatment (10.43±0.33 mm) were statistically higher when compared with group II dogs. This finding was in agreement with Gupta and Sinha (1996) who reported higher interventricular septal dimensions in human patients with clinical hypothyroidism.

Left ventricular internal diameter at end diastole (LVIDd) values of group I dogs on 0th (33.43±1.21 mm) and 30th day of treatment (31.29±1.08 mm) were not statistically different from values of group II (30.73±2.48 mm). But there was significant reduction (P<0.05) in left ventricular internal diameter (LVIDd) at end diastole on 30th day of treatment when compared with value on 0th day of treatment. The latter finding was in partial agreement with finding of reduction in elevated

LVIDd values in hypothyroid dogs after treatment with levothyoxine as reported by Karlapudi *et al.* (2012) and Phillips and Harkin (2003). This reduction in LVIDd values resulted in significant lowering (P<0.05) of end diastolic volume, stroke volume, cardiac output of group I dogs by 30th day of treatment on comparison with these values 0th day of treatment. However, those values of group I dogs on 0th day and 30th day of treatment were not statistically different from values of group II dogs.

The mean posterior wall thickness at end diastole of group I dogs on 0th day (10.8±0.61 mm) and 30th day of treatment (11.32±0.56 mm) were significantly higher (P<0.01) on comparison with group II dogs (8.6±0.62 mm). However, there was no statistically significant difference between values of group I dogs on 0th and 30th day of treatment. The mean posterior wall thickness at end systole of group I dogs on 0th day (13.23±0.76 mm) and 30th day of treatment (14.87±0.81 mm) were significantly higher (P<0.01) in comparison with value of group II dogs (11.05±0.64 mm). There was no statistically significant difference between values of group I dogs on 0th and 30th day of treatment. The above findings of present study were in agreement with finding of significantly high posterior wall thickening in humans with clinical hypothyroidism (Gupta and Sinha, 1996).

The mean E point to septal separation (EPSS) value of group I dogs on 0th day (5.03±0.29 mm) and 30th day of treatment (5.1±0.26 mm) were significantly lower than group II dogs **(**p<0.01) either. Range of EPSS value in normal Labrador Retriever dogs were 4.0-7.5 mm (Gugjoo *et al*., 2014). In the present study, in which majority of cases were Labrador Retriever dogs, even though there was statistically low EPSS values, they were within the normal range as suggested by the earlier worker. EPSS value will be elevated in cases of dilated cardiomyopathy and severe hypothyroidism (Flood and Hoover, 2009) which were not diagnosed in present study.

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