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Study the Electrocardiographic and Echocardiographic Parameters in Healthy Persian Cats in Iran

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ABSTRACT

Electrocardiography and Echocardiography are diagnostic tools in diagnosis of cardiovascular diseases. In this study electrocardiography and echocardiography indices are evaluated in Persian cats, and presence of any possible relation between these indices and age and gender are assessed. This survey was conducted on 120 paersian cats in Tehran city, 60 cats of male and 60 female (in each gender 30 cats under 8 months of age and30cats more than 8 months of age). At first the animals evaluated clinically and then echocardiography and electrocardiography were done. Echocardiography was done from standard views of right and left parasternal regions. For electrocardiography the case was placed on its right side on a dielectric surface and after application of jell attachment of electrocardiography forceps were done and recording of standard 6 lids ECG was done. In echocardiographic indices: cardiac output ($p<0.001$)and stroke volume ($p<0.001$), left ventricular volume($p<0.001$), left atrial diameter ($p=0.006$), pulmonary artery diameter ($p=0.028$), and ejection fraction($p<0.001$) had significant positive relationship with aging. increasing of age caused an enhacement of these factores. Interventricular septum($p<0.001$) had significant positive relationship with aging and females. increasing of age caused an enhacement of this factor and this index in females was more than males. And in electrocardiography indices, R wave height($p<0.001$) had significant positive relationship with aging. increasing of age caused an enhacement of this factor. Based on the resuts of this study it was cleared that some indices in echocardiography and electrocardiography could have relationship with age and/or gender in healthy Persian cats. So interpretation of the results of these two diagnostic tools should be done in light of age and/or gender.

KEYWORDS

Echocardiography, Electrocardiography, Persian cat, Age, Gender.

Introduction

The Persian cat is one of the oldest and most well-known cat breeds. This breed is among the most popular cats among pet owners. Persian cats are predisposed to various diseases, including polycystic kidney disease, respiratory disorders, ocular disorders, and cardiac diseases. The most important cardiac disease in this breed is hypertrophic cardiomyopathy (HCM) (21,22). An electrocardiogram (ECG) is a device that records the electrical activity of the heart using electrodes placed on different areas of the skin, producing a graphical representation known as an electrocardiograph or ECG trace (10). This method is used to diagnose many cardiac and non-cardiac disorders such as arrhythmias,

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myocardial hypertrophy, causes of dyspnea, electrolyte disturbances, and drug effects (7). Echocardiography is a non-invasive diagnostic method using harmless sound waves to visualize cardiac structures and measure blood flow velocity (2). This technique provides a precise view of the heart walls, valves, and the origins of the great arteries (3). Being non-invasive is one of its main advantages (7). Echocardiography is used to confirm congenital heart disease, evaluate abnormal heart sounds, valve disorders, myocardial function, cardiac output, valvular infections, the presence of thrombi or emboli, atrial fibrillation, pulmonary hypertension, and more (2,6). Electrocardiography and echocardiography are both useful, accessible, and relatively cost-effective tools for diagnosing and monitoring cardiac diseases. Electrocardiography evaluates the size of heart chambers and the speed of electrical conduction (11). Echocardiography assesses chamber and wall dimensions and myocardial and blood flow motion (1,4). Both methods can be affected by physical changes—for instance, obesity may increase myocardial mass, while heavy activity can influence myocardial and blood flow velocity as well as myocardial and chamber dimensions (9,12). Since these physical variations naturally occur with age and sex, they can alter ECG and echocardiographic indices. Clinicians may misinterpret these normal changes (sometimes markedly outside the normal range) as pathological. This could result in misdiagnosis or inappropriate monitoring of cardiac diseases. This study evaluates standard indices of ECG and echocardiography in Persian cats and their relationship to age and sex to enable more accurate and timely diagnosis of cardiac diseases in this breed.

Materials and Methods

The study population consisted of 120 clinically healthy Persian cats (60 males and 60 females, with 30 individuals over 8 months and 30 under 8 months in each sex group) presented to veterinary hospitals in Tehran. Cats underwent clinical examination to confirm health prior to enrollment. Echocardiography and ECG were then performed. For echocardiography, fur on the right parasternal region was clipped, the cat restrained appropriately, and imaging performed (20). The echocardiographic indices included LV study, CO, SV, LAD, EPSS, LA:AO, AOD, PULD, Ao Vmax, Ao PG, Pul Vmax, Pul PG (representing left ventricle indices, cardiac output, stroke volume, left atrial diameter, E-point to septal separation, left atrium-to-aorta ratio, aortic and pulmonary diameters, and maximum flow velocities and pressure gradients). Imaging planes included right parasternal short-axis views at the left ventricle, right parasternal long-axis outflow tract views, right parasternal short-axis views of the pulmonary artery, mitral valve, and aortic root (8). For ECG, fur at lead attachment points was clipped if needed, the cat positioned in right lateral recumbency on an insulated surface, and skin moistened with sterile gel or alcohol spray before attaching leads. Six standard limb leads were used for ECG tracing (18). ECG indices included P and QRS wave voltage and duration, PR interval, and T wave voltage, duration, and morphology. QT interval and electrical axis were not assessed. Data were analyzed with SPSS v24. Quantitative descriptive data were presented as Mean ± SEM. One-way ANOVA with post-hoc Tukey and LSD tests were used; $P \leq 0.05$ was considered statistically significant.

Results

Sixty Persian cats of both sexes were evaluated, divided equally into groups above and below 8 months. Descriptive data by age and sex are presented in the corresponding tables.Echocardiographic findings: Aortic indices (diameter, pressure gradient, maximum velocity) showed no significant correlation with age or sex. Among pulmonary artery indices (diameter, gradient, velocity), only artery diameter was significantly larger in females over 8 months ($P=0.031$). Left ventricular septal thickness in diastole was significantly greater in older females than in younger females, older males, and younger males ($P<0.001$). Similar trends were noted in systolic septal thickness ($P<0.001$). Left ventricular internal diameter in diastole was significantly larger in older cats (~14 mm) than younger ones (~8 mm) ($P<0.001$), as was systolic diameter (~7 mm vs ~4 mm) ($P<0.001$). Left ventricular free wall thickness in diastole was higher in females under 8 months (~5 mm) than in males under 8 months, older males, and older females (P values 0.033, <0.001, 0.019 respectively), and higher in males under 8 months

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(~4.3 mm) than in older males (~3.7 mm) (P=0.037). Ejection fraction was significantly higher in cats over 8 months (82% in females, 81% in males) than in younger groups (76% and 75%) (P=0.021). Left ventricular end-diastolic volume (~12 mm³) and end-systolic volume (~2 mm³) were significantly greater in older cats than younger ones (~2 mm³ and ~0.5 mm³ respectively) (P<0.001). Mitral EPSS was significantly higher in older females (~2 mm) than younger males (~1 mm) (P=0.004). Cardiac output and stroke volume were significantly greater in older cats (females 1767, males 1660 vs females 376, males 403) (P<0.001). Left atrial diameter was higher in older females (9.136 ± 0.400) and older males (9.260 ± 0.425) than younger females (7.590 ± 0.355) (P=0.011, P=0.022).

Electrocardiographic findings: P wave amplitude was significantly higher in older males (~0.176) than younger females (~0.145) (P=0.020). R wave amplitude was significantly higher in older males (~0.716) than younger males (~0.593) and younger females (~0.543) (P=0.007, P<0.001), and higher in older females (~0.690) than younger females (~0.543) (P=0.001). QT interval and electrical axis were not assessed. All ECG and echocardiographic indices remained within normal ranges.

Table 1. Echocardiographic parameters of the heart and basic arteries.

Indices	group	Number	Standard error of the mean
Aortic diameter	8 >male	30	9.22±0.33
	8 <male	30	9.86±0.24
	8 >female	30	9.70±0.24
	8 <female	30	9.97±0.20
	total	120	9.69±0.13
Maximum velocity in aorta	8 >male	30	0.92±0.03
	8 <male	30	1.01±0.04
	8 >female	30	0.94±0.03
	8 <female	30	0.91±0.03
	total	120	0.95±0.02
Pressure gradient in aorta	8 >male	30	3.47±0.22
	8 < male	30	4.27±0.34
	8 >female	30	3.67±0.26
	8 <female	30	3.46±0.28
	total	120	3.72±0.14
Left atrium: aorta	8 >male	30	0.91±0.03
	8 <male	30	0.93±0.03
	8 >female	30	0.85±0.04
	8 <female	30	0.91±0.03
	Total	120	0.90±0.02
EPSS	8 >male	30	1.50±0.11

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	8 <male	30	1.97±0.15
	8 >female	30	1.67±0.12
	8 <female	30	2.13±0.13
	total	120	1.82±0.07
Left atrium diameter	8 >male	30	8.30±0.31
	8 <Male	30	9.26±0.43
	8 >female	30	7.59±0.36
	8 <female	30	9.14±0.40
	total	120	8.57±0.20
Pulmonic artery diameter	8 >male	30	5.33±0.17
	8 <male	30	5.18±0.15
	8 >female	30	4.77±0.13
	8 <female	30	5.39±0.18
	total	120	5.17±0.08
Maximum velocity in pulmonic artery	8 >male	30	0.66±0.03
	8 <male	30	0.66±0.03
	8 >female	30	0.65±0.03
	8 <female	30	0.59±0.04
	total	120	0.64±0.01
Pressure gradient in pulmonic artery	8 >male	30	80±0.14.
	8 <male	30	1.86±0.16
	8 >female	30	1.68±0.14
	8 <female	30	1.57±0.18
	Total	120	1.73±0.08
interventricular septum diameter in diastole	8 >male	30	3.35±0.11
	8 <male	30	3.38±0.14
	8 >female	30	3.50±0.15
	8 <female	30	4.20±0.18
	total	120	3.61±0.08

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indices	Group	Number	Standard error of the mean
Interventricular septum diameter in systole	8 >male	30	5.05±0.14
	8 <male	30	4.84±0.18
	8 >female	30	4.89±0.14
	8 <female	30	6.43±0.28
	Total	120	5.30±0.11
Left ventricular free wall diameter in diastole	8 >male	30	4.36±0.14
	8 <male	30	3.70±0.14
	8 >female	30	5.02±0.17
	8 <female	30	4.31±0.22
	Total	120	4.35±0.09
Left ventricular free wall diameter in systole	8 >male	30	6.68±0.17
	8 <male	30	7.15±0.24
	8 >female	30	6.60±0.22
	8 <female	30	6.92±0.32
	Total	120	6.84±0.12
Left ventricular internal diameter in diastole	8 >male	30	8.68±0.28
	8 <male	30	14.71±0.62
	8 >female	30	8.12±0.29
	8 <female	30	14.75±0.65
	Total	120	11.57±0.38
Left ventricular internal diameter in systole	8 >male	30	4.23±0.22
	8 <male	30	7.11±0.35
	8 >female	30	3.76±0.18
	8 <female	30	7.08±0.44
	Total	120	5.54±0.21
Left ventricular end diastolic volume	8 >male	30	2.82±0.22
	8 <male	30	12.09±1.19
	8 >female	30	2.54±0.22

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	8 <female	30	12.15±1.35
	Total	120	7.40±0.62
Left ventricular end systolic volume	8 >male	30	0.66±0.06
	8 <male	30	1.96±0.20
	8 >female	30	0.56±0.05
	8 <female	30	2.11±0.32
	Total	120	1.32±0.12
Ejection fraction	8 >male	30	75.77±1.28
	8 <male	30	81.77±1.29
	8 >female	30	76.67±1.19
	8 <female	30	82.23±1.17
	Total	120	79.11±0.66
Fractional shortening	8 >male	30	51.40±1.45
	8 <male	30	51.23±1.52
	8 >Female	30	53.47±1.39
	8 <female	30	52.50±1.58
	Total	120	52.15±0.74
Stroke volume	8 >male	30	2.17±0.18
	8 <male	30	10.14±1.06
	8 >female	30	1.97±0.18
	8 <female	30	10.05±1.10
	Total	120	6.08±0.53

Table 2. Electrocardiographic and cardiac output indices.

Indices	Group	Number	Standard error of the mean
Cardiac out put	8 >male	30	403.87±30.63
	8 <male	30	1660.33±152.61
	8 >female	30	376.93±36.25
	8 <female	30	1767.73±182.50
	Total	120	1052.22±85.32

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P wave width	8 >male	30	0.03±0.00
	8 <male	30	0.03±0.00
	8 >female	30	0.03±0.00
	8 <female	30	0.03±0.00
	Total	120	0.03±0.00
P wave height	8 >male	30	0.16±0.01
	8 <male	30	0.18±0.01
	8 >female	30	0.15±0.01
	8 <female	30	0.17±0.01
	Total	120	0.16±0.00
R wave width	8 >male	30	0.03±0.00
	8 <male	30	0.03±0.00
	8 >female	30	0.03±0.00
	8 <female	30	0.03±0.00
	Total	120	0.03±0.00
R wave height	8 >male	30	0.59±0.03
	8 <male	30	0.72±0.02
	8 >female	30	0.54±0.03
	8 <female	30	0.69±0.02
	Total	120	0.64±0.01
P-R interval	8 >male	30	0.06±0.00
	8 <male	30	0.07±0.00
	8 >female	30	0.06±0.00
	8 <female	30	0.07±0.00
	Total	120	0.07±0.00
T wave width	8 >male	30	0.03±0.00
	8 <male	30	0.03±0.00
	8 >female	30	0.03±0.00
	8 <female	30	0.03±0.00
	Total	120	0.03±0.00

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T wave height	8 >male	30	0.16±0.01
	8 <male	30	0.19±0.01
	8 >Female	30	0.15±0.01
	8 <female	30	0.18±0.01
	Total	120	0.17±0.01

Discussion

Numerous factors influence echocardiographic and ECG indices in both human and veterinary medicine (17,19,25). Due to the wide variability of these factors, definitive documented effects are rare in reference texts, highlighting the need for further studies. This study showed several indices significantly affected by age and/or sex in Persian cats.

In ECG, R wave amplitude was higher in older males, indicating a significant age correlation, consistent with previous studies. Lourenço et al. (2003) found R wave voltage rises in early kittenhood due to left ventricular growth (14). P wave amplitude differences were observed but were not statistically correlated with age or sex; they may reflect body size. Schober et al. (2007) noted ECG is insensitive but specific for detecting left atrial enlargement (23).

No significant correlations with age or sex were seen for P and QRS wave duration, PR interval, or T wave indices. This may be due to minimal changes below ECG detection thresholds, insufficient sample size, or absence of physiological correlation. Previous studies (27,10) indicate QT interval and arrhythmias vary naturally, reinforcing that ECG must be interpreted cautiously.

In echocardiography, pulmonary artery diameter was larger in older females, EF was higher in older cats, and stroke volume and CO correlated with age. Findings align with Kayar et al. (2014) showing male cats had larger LA and Ao dimensions (13). Septal thickness correlated with weight, consistent with Campbell et al. (2007) showing hydration status affects wall thickness (5). Free wall thickness differences conflicted with other studies, possibly due to dehydration or measurement error. Fox et al. (1985) showed sedation alters wall thickness and EF (8).

EPSS differences lacked significant correlation with age or sex. Left atrial diameter was larger in older cats, consistent with other studies linking weight to echocardiographic indices (13). No correlations were found for FS, LA:Ao ratio, aortic indices, pulmonary flow velocity, or systolic LV free wall thickness.

Overall, most echocardiographic indices correlated with age and sex, particularly in females. Only LV free wall thickness was higher in younger females. These findings indicate sex and age significantly affect interpretation of echocardiographic indices in Persian cats, warranting further research.

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