Iraqi Journal of Veterinary Sciences, Vol. 39, Supplement II, 2025 (125-133)
Proceedings of the 6th Scientific Conference, College of Veterinary Medicine, University of Karbala

Iraqi Journal of Veterinary Sciences

www.vetmedmosul.com

Evaluation of cardiac arrhythmias in horses

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Article information

Article history:
Received 17 April, 2025
Accepted 09 September, 2025
Published 12 November, 2025

Keywords:
Electrocardiogram
Cardiac arrhythmias
Risk factors
Horses

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Abstract

Electrocardiogram abnormalities are common in racehorses and can have effect on performance. The aim of the study is to analyze the Electrocardiographic problem results and measure frequencies of various cardiac arrhythmias. The study was conducted during a period between September 2023 to August 2024, Standard electrocardiographic recordings were obtained from all horses, hematology, biochemical and cardiac troponin levels were measured. Out of the 114 poorly performing adult horses 40 cases without arrhythmia considered as a control group. Seventy-four horses (64.9%) had at least one type of cardiac arrhythmia, atrial fibrillation was observed in 60 cases (52.63%), and 29 horses (25.44%) had left axis deviation and left ventricular hypertrophy. The most frequent conduction anomaly was atrioventricular block in 34 cases (29.82%), followed by QT prolongation in 54 horses (47.36%), and QTc prolongation was seen in 50 horses (43.85%). Bradycardia was detected in 20 cases (17.54%), and ST-segment depression was present in 25 horses (21.93%). Conduction disturbances, including left bundle branch block in 13 horses (11.40%) and right bundle branch block in 26 horses (22.81%). Troponin levels were significantly elevated in cases of arrhythmia. The incidence of atrial fibrillation was significantly higher in male horses in all age groups except the oldest. Because cardiac arrhythmia may lead to racehorse exercise intolerance, suboptimal performance, the early diagnosis is important to allow veterinarians to make long-term treatment strategies, furthermore, the electrocardiography, along with cardiac biomarker cardiac troponin, is essential.

DOI: 10.33899/ijvs.2025.159224.4233,

Introduction

Horses suffer from cardiac arrhythmias which are common ranging from 0.5 to 10 % prevalence in the equine population (1). Cardiac arrhythmias in horses have an incidence that varies depending on some factors such as breed, age, and level of exercise with incidence of cardiac arrhythmias as high as 0.24% found in a group of athletic horses (2). The prevalence of cardiac arrhythmias in Standardbred horses is up to 20% (1). Other environmental factors, including atmospheric temperature stress, and underlying health conditions are also known to affect the incidence of cardiac arrhythmias in horses (2). Horses can have cardiac arrhythmias, which are medically important because their prevalence, incidence, health consequences, and role in sudden death are not well understood, as they are in horses typically due to a lack of readily available information in both the horse owner and veterinarian (3,4). Information about the prevalence and incidence of atrial fibrillation (AF) and another cardiac arrhythmia has been previously provided in horses. Wright and Lafferty (5) reported that 4.9% of the horses have AF incidence. Horses with a history of AF had a particularly high incidence of relapse, recurrent AF was a problem in equine participants, and monitoring and treating this condition was particularly quite important (6). Moreover, Sweeney and Jerger (7) reported the importance of AF in performance horses. Dreyer and van der Veen (8) also evaluated the long-term

outcome of horses. Horses have shown a higher frequency of cardiac arrhythmia in certain breeds, such as those suffering from equine axonal atrophy in Quarter Horses (9). Although the hearts of these horses were thin and the horses were afflicted with subclinical cardiomyopathy (10), that means thinning of the heart muscle, increased cardiac arrhythmias and there may be a breed predisposition that should be investigated further. Diagnostic biomarkers investigated in terms of the horse with arrhythmia include plasma cardiac troponin I (cTnI) concentrations (11). The median cTnI level in horses with ventricular arrhythmias was tenfold higher than those with AF (10) and the cTnI level can be used to assess myocardial and damage (12), Therefore guide treatment strategies (13). Although many studies were done in Iraq for detect bacterial diseases in horse (14-16), many manuscripts were done about parasite diseases (17), some researchers focused their effort about detect deferent physiological parameters and new technique for diagnose diseases in Arabian horses (18-20), scientific works related to electrocardiography of horses in Iraq still scarce and little information's had been provided (21).

So that, the study was done to locate the prevalence of cardiac arrhythmias and their risk factors in a cohort of racehorses and to know how many arrhythmias occur at a single time point in horses, in addition, monitor the heart rhythm of the same horses over a time period looking for changes, identifying new problem horses, and tracking horses who already had a problem.

Materials and methods

Ethical approval

Taking blood samples from animals of study and making clinical examinations were permitted in accordance with Institutional Animal Care and Use Committee, College of Veterinary Medicine, University of Mosul, Ethical code number UM.VET.2023.146. on 15-8-2023.

Animals of study

Arabian and Thoroughbred horses from 4 to 11 years of age at 340- 390 kg in weight, 67 stallions, and 47 mare and 40 healthy horses with normal ECG is consider a control group for comparison, were housed at the Equestrian Club (Equestrian Club) in the Al-Shallalat area, and at the different areas around Mosul, Iraq. Features about the presence of arrhythmias, and associated clinical conditions, were obtained. The frequency of cardiac arrhythmia presented was found through the counting of horses that presented these conditions. These horses were followed over a particular year during a period between September 2023 to August 2024.

Clinical examination

Predisposing factors for the development of cardiac disease were estimated through complete clinical examination of all horses followed by electrocardiographic studies. Visual mucosal assessment, determination of hydration status and capillary refill time, palpation of superficial lymph nodes and arterial pulse, measurement of heart rate and respiratory rate, assessment of intestinal motility, measurement of rectal temperature, and review of the animal's history were all included in this examination.

Hematology and blood chemistry

Cardiac Troponin I (cTnI) and various hematological and biochemical parameters in horses were determined. The tubes containing blood were tested for blood clotting of adequate clotting for 10 to 20 minutes at room temperature. Then the serum was quickly agitated at 2000-3000 rpm for 20 minutes to separate the serum from the artificial components. To quantify serum cTnI, the serum was analyzed by Equine Cardiac Troponin I Sandwich ELISA Kit (Sun Long Biotech Co., LTD), and rapid ending OD readings were taken at 450 drops of the microtiter plate reader. The hematological parameters include calculation of total white blood cells (WBC), lymphocytes (LYM), monocytes (MID), granulocytes (GRA), total erythrocyte count (RBC), hemoglobin concentration (HGB), hematocrit (HCT), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular hemoglobin (MCH), mean corpuscular volume (MCV), and total platelets count (PLT), were performed by an Auto Hematology Analyzer from Rayto company, Germany. Moreover, biochemical analysis including including urea, calcium (Ca), cholesterol, Creatinine, total bilirubin (TBIL), total protein (TP), alkaline phosphatase (ALP), aspartate aminotransferase (AST), alanine aminotransferase (ALT), and gamma-glutamyl transferase (GGT) were performed by Thermoscientific indiko, from Thermofischer company, made in USA and by using Cobas, from Roche company, made in Germany. Information about health status, sex, and physiological difference between males and females were provided.

Electrocardiogram (ECG)

Electrocardiographic recordings were obtained using a portable electrocardiograph (EDAN VET ECG, model VE-100, 220 V-240 V/100 V-115 V 50 Hz/60 Hz, 0.3 max, Edan Instrment Inc, Shenzhen, People's Republic of China). The horses were harnessed and restrained in a standing position with the limbs equivalent to each other, without the use of tranquillizer, sedation, or anaesthesia. ECG tracings were don serially on all horse by the leads in the frontal plane (I, II, III, aVR, aVL, and aVF). For the bipolar basal electrode system, the yellow electrode was placed on the left side above the apex of the heart just behind the ulna, the red electrode was placed on the right side, from the skull to the scapula, and near the jugular vein, with the ground electrode attached to the withers. ECG data were collected and recorded using the specified lead configuration and

electrode placement (22). To estimate heart rate (HR) from the ECG, measure the R-R interval in the trace and then use the heart rate formula: Heart rate (bpm) = 1500 / R-R interval in mm. To calculate the QT interval from this ECG trace, the paper speed is 25 mm/s (as shown in the trace), and the QT interval is calculated from the start of the Q wave until the end of the T wave. Using the provided trace, visually estimate the number of small squares (1 mm each) within this interval, and convert this to time. Each small square at 25 mm/s represents 0.04 seconds (40 ms) and then multiply the number of small squares by 0.04 to obtain the QT interval in seconds. Bazett's formula is used to correct the QT interval for heart rate: QTc=QT (milliseconds)/√RR interval (seconds). The R-R interval (the distance between two consecutive R waves) is measured in small squares, and its time is calculated (small squares × 0.04).

Statistical analysis

Descriptive statistics were applied to the ECG findings and the clinical pathology observed in the study group. For normally distributed data the independent t-tests were run to test if there were differences between male and female horses. Mann-Whitney U test was used with the data which was not normally distributed. Statistically significant was taken as a $P<0.05$.

Results

An overview of the frequencies of cardiac arrhythmias in 114 horses, divided by sex, can be found in (Table 1). There were 74 cases of cardiac arrhythmia and 40 cases did not have any type of arrhythmia in the overall population, indicating a frequency of 64.9%. While female horses exhibited a 55.3% frequency with 26 cases, male horses had a higher frequency of 71.6% with 48 recognized (Table 1). ECG data were collected from 114 horses, including information on QRS amplitude, mean axis shifts, S-T segment depression, and specific arrhythmia patterns. Atrial fibrillation frequency was 52.63%, Left axis deviation with left ventricular hypertrophy 25.44% suggests increased left ventricular workload. QTc prolongation 43.85% was the most frequently observed abnormality, suggesting a repolarization abnormality that may lead to arrhythmias. LBBB, RBBB, and ST-segment depression occurred in 11.4, 22.81, and 21.93% of cases, respectively (Table 2). The statistical Analysis of ECG parameters showed cases have prolonged PR intervals, suggesting conduction delay (AV block) or sinus bradycardia. All cases have widened QRS, indicating some level of ventricular conduction delay (statistically significant). Horses have a significantly prolonged QT interval, which could predispose to arrhythmias (Table 3).

Table 1: frequencies of cardiac arrhythmias in male and female racehorses

Gender	Total population	Diseased horses	Frequency (per 100)
Male	67	48	71.6
Female	47	26	55.3
Total	114	74	64.9

Table 2: The Frequency of different cardiac arrhythmias in the 114 racehorses

Type of Cardiac Arrhythmia	N=114	Frequency
Atrial Fibrillation (AF)	60	52.63%
QT Prolongation	54	47.36%
QTc Prolongation	50	43.85%
AV Block	34	29.82%
Left Axis Deviation with LVH	29	25.44%
Right Bundle Branch Block	26	22.81
ST Segment Depression	25	21.93
Mild Bradycardia	20	17.54
Left Bundle Branch Block	13	11.40
Normal ECG	40	35.08

Table 3: The ECG parameters for all horses(n=114), including normal reference values, individual case measurements, and mean±SD (Standard error) for statistical analysis.

ECG Parameters	Heart Rate (bpm)	R-R Interval (sec)	P Wave Duration (sec)	PR Interval (sec)	QRS Duration (sec)	QT Interval (sec)	Mean Electrical Axis (°)
Reference Range	28-44	1.36-2.14	0.06-0.12	0.24-0.46	0.08-0.14	0.32-0.45	-45t°o+120°
Atrial Fibrillation	58±3.5	1.03±0.06	-	0.19±0.01	0.06±0.01	0.36±0.02	+51.6±4.6
QT Prolongation	40±5	1.5±0.1	0.02-0.03	2.0(↑)±0.04	0.6(↑)±0.02	3.1(↑)±0.02	+60°±5
AV Block	38±4	1.4±0.05	0.025±.02	1.60(↑)±0.03	0.22(↑)±0.01	0.42±0.02	+62°±3
Left Axis Deviation with LVH	36±4	1.6±0.1	0.03±.005	0.52(↑)±0.06	0.08±0.01	0.36±0.02	+45°±5
Bundle Branch Block	32±5	1.7±0.1	0.02±0.003	1.60(↑)±0.01	0.48(↑)±0.01	2.4(↑)±0.02	+30°±5
ST Segment Depression	34±4	1.5±0.1	0.02±0.003	0.14±0.01	0.10±0.02	0.30±0.01	+40°±5
Sinus Bradycardia	20±5	1.9±0.2	0.02±0.003	2.0(↑)±0.02	0.8(↑)±0.01	3.2(↑)±0.02	+20°±4
Normal ECG	34±6	1.33±0.1	0.025±.004	0.26±0.02	0.09±0.01	0.35±0.02	+35 °±5

(↑) Prolonged compared to normal values. $P<0.05$ (Significant).

The ECG changes in horses affected by atrial fibrillation typically include irregularly irregular R-R intervals, absence of P waves, and irregular, rapid, and often chaotic atrial activity. Additionally, there may be an irregular ventricular response due to the irregular atrial activity. The baseline may also show irregular undulations due to the absence of organized atrial depolarization. The ventricular rate is often rapid and irregular, reflecting irregular atrial activity. These ECG changes are characteristic of atrial fibrillation in horses and are indicative of arrhythmia's presence (Figures 1 and 2). 29 out of the 114 cases (approximately 25.44%) exhibit left axis deviation in conjunction with left ventricular hypertrophy, this would indicate a relatively high prevalence of this specific combination of findings within the sample. However, it's important to thought that the actual percentage can vary based on the specific characteristics of the study population, and these figures are provided as an illustrative example. It's also crucial to consider that the presence of left axis deviation and left ventricular hypertrophy in horses should be interpreted in the context of a thorough clinical and diagnostic evaluation, as there can be multiple factors contributing to these findings. Abnormal electrocardiographic findings, such as increased QRS amplitudes in cases of cardiac hypertrophy (Figure 3) and decreased QRS amplitudes in horses with anemia, chronic pleuritis, and pericardial effusion when sinus tachycardia which appeared with elevated heart rate above the normal range (>48 bpm). Reduced amplitude of QRS complexes due to pericardial effusion and electrical alternans by beat-to-beat variation in QRS amplitude or axis, indicating the heart's movement within a fluid-filled pericardial sac. Mild elevation or depression in the ST segment reflecting pericardial inflammation was recorded and analyzed (Figure 4). Mean electrical axis shifts of the QRS configuration were assessed in cases related to congenital right-sided cardiac disease and electrolyte imbalances in stressed horses (Figure 5). Atrioventricular blocks with variable PR intervals and narrow QRS complexes were also seen in horses at rest and during exercises (Figures 6 and 7). Specific electrocardiographic patterns, including ST segment depression in cases of shock, and the presence of left bundle branch block and right bundle branch block were characterized (Figures 8 and 9).

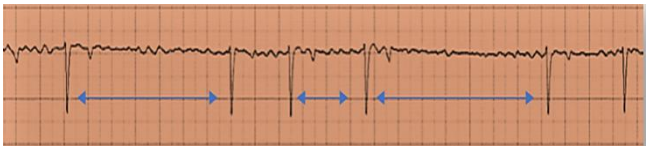

Figure 1: Electrocardiogram of racehorse with atrial fibrillation. Note the irregularly spaced QRS complexes, R-R intervals vary from beat to beat (blue arrow), P wave was absence, and lack a smooth baseline. The coarse waves that occur in the recording are f (fibrillation) waves.

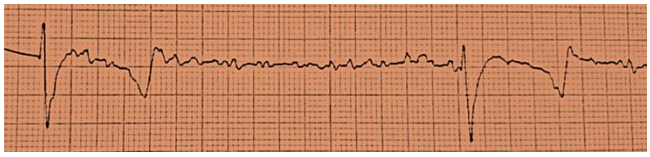

Figure 2: ECG from a Thoroughbred horse at rest showing a transitory period of atrial fibrillation (HR =60bpm). This horse was first identified with paroxysmal atrial fibrillation after an episode of distress during exercise, but additional investigations discovered it was a recurrent problem.

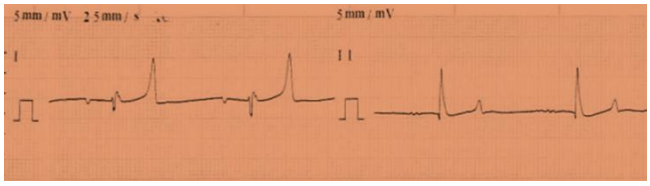

Figure 3: ECG from a horse with Left axis deviation and cardiac hypertrophy in lead II.

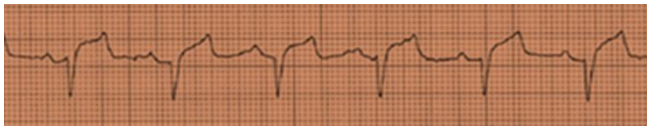

Figure 4: This ECG suggests that the horse may have pericarditis. A faster heart rate than normal (HR= 72), low voltage QRS. The heart's electrical signals change in height from beat to beat (electrical alternans P +65°, QRS +10°, T-115°) because it is moving inside a fluid-filled sac.

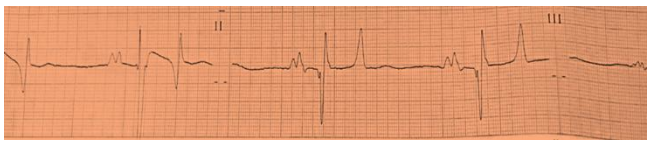

Figure 5: The P waves in some leads appear tall and peaked rather than the usual rounded morphology seen in normal sinus rhythm. Tall or peaked P waves are often associated with right atrial enlargement (RAE). Tall T waves may reflect: Electrolyte disturbances (hyperkalemia, hypocalcemia).

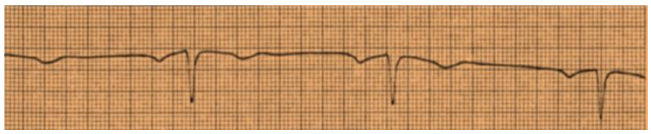

Figure 6: ECG of horse has First-degree AV block and sinus bradycardia (HR=21 bpm), Prolonged PR interval with negative T wave.

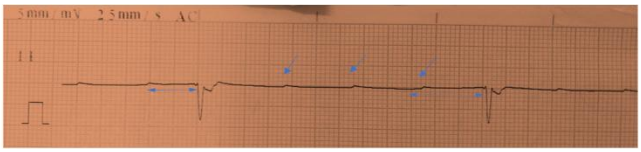

Figure 7: ECG of mare (11-year-old) examined after exercise collapse episode. A third-degree AV block with a junctional (high ventricular) escape rhythm (blue arrow). variable PR intervals (blue double head arrow), narrow QRS complexes (0.12 sec.), atrial rate of 70 beats/min, and ventricular rate of ~20 beats/min.

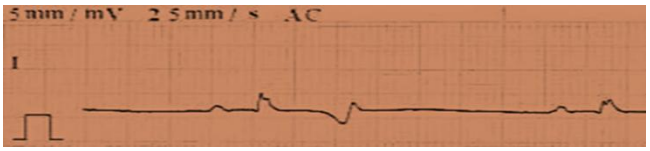

Figure 8: ECG of a horse with a block right bundle branch leads to wide, large S waves in lead I, II, III, and aVF.

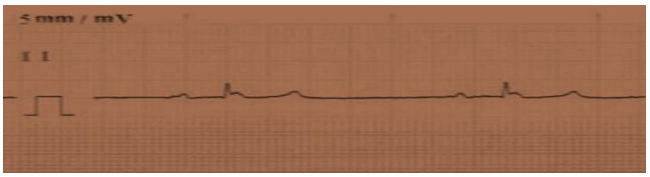

Figure 9: A left bundle branch block cause wide and bizarre QRS complex, with positive QRS complexes in leads I, II, III, and aVF. Bundle Branch Block, PR interval: 1.60 sec., QRS duration: 0.48 sec., QT interval: 2.40 sec.

Analysis hematological parameters of horses in this study in combination with the presence of cardiac arrhythmia indicates a complex interaction between the horse's red blood cells (CBC) and cardiovascular function. Whereas most blood parameters, such as white blood cells, LYM, GRA, RBC, HCT, MCH, MCV, and PLT, continue within normal ranges, significant findings of low MID (0.24±0.04 × 10^3/μL) and MCHC (342.50±16.50 g/L) indicate potential immune system challenges and red blood cell concentration problems. The hemoglobin (HGB) level 119.50±4.50 g/L is also near the lower limit of normal. There were differences in overall means between females and males show minimal variation and non-significant P values (all P>0.05), the MID parameter approaches significance with a P<0.05 (Table 4).

A comprehensive overview of biochemical parameters measured in females and males, including glucose, urea, calcium (Ca), cholesterol, creatinine, total bilirubin (TBIL), total protein (TP), alkaline phosphatase (ALP), aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma-glutamyl transferase (GGT), were provided in Table 5. All parameters show significant differences between sexes, with P values of 0.0001, indicating a strong statistical correlation. Notably, males exhibit higher levels across all measured biochemical markers, including elevated glucose and cholesterol levels, which are critical to consider in the context of cardiac health (Table 5).

Troponin I (cTnI) and Troponin T (cTnT) levels in normal horses were within reference ranges. Results show elevated mean troponin levels significantly (cTnI: 0.110±0.025 ng/mL, cTnT: 0.095±0.020 ng/mL), in cases of atrial fibrillation (AF), and in left axis deviation with left ventricular hypertrophy (LVH) (cTnI: 0.075±0.015 ng/mL, cTnT: 0.080±0.018 ng/mL), and the left bundle branch block (LBBB) (cTnI: 0.095±0.022, cTnT:0.102±0.019), a mild troponin rises with no significant P values, find in first-degree AV block and right bundle branch block (RBBB). Notably, cases of QTc prolongation indicated an increased risk of arrhythmia-related damage (cTnI: 0.085±0.02 ng/mL, cTnT: 0.090±0.021 ng/mL) and ST depression in shock cases presented markedly elevated troponin levels (cTnI: 0.130±0.03 ng/mL, cTnT: 0.125±0.028 ng/mL) (Table 6).

Table 4: Hematological Parameters (Means±Standard Deviation) for female and male horses have cardiac Arrhythmias

Parameter	Control group	Female	Male	P value
WBC (×10^3/μL)	5.0±0.12	7.70±0.06	7.61±0.23	> 0.05
LYM (×10^3/μL)	1.5±0. 45	3.12±0.04	3.07±0.02	> 0.05
MID (×10^3/μL)	0.3±0.01	0.31±0.02	0.24±0.04	< 0.05
GRA (×10^3/μL)	2.0±0.08	4.28±0.06	4.30±0.17	> 0.05
RBC (×10^6/μL)	6.5±0.12	7.17±0.07	7.08±0.13	> 0.05
HGB (g/L)	120±20.0	116.60±2.83	119.50±4.50	< 0.05
HCT (%)	32±0.48	32.34±0.22	32.05±0.35	> 0.05
MCHC (g/L)	350±45.0	342.40±5.54	342.50±16.50	< 0.05
MCH (pg)	11±1.70	16.34±0.21	15.95±0.35	> 0.05
MCV (fL)	35±0.50	45.98±0.29	44.85±0.95	> 0.05
PLT (×10^9/L)	100±0.40	152.00±4.69	156.50±8.50	> 0.05

Table 5: Comparison of biochemical parameters for female and male horses that have cardiac arrhythmias

Parameter	Control group	Female	Male	P value
Glucose (mmol/L)	3.50±0.5	2.56±0.64	5.50±0.75	0.0001
Urea (mmol/L)	2.50±1.0	2.58±0.14	3.90±0.24	0.0001
Ca (mmol/L)	2.20±0.2	0.36±0.12	2.33±0.47	0.0001
Cholesterol (mmol/L)	2.50±0.5	4.20±0.80	13.65±0.65	0.0001
Creatinine (µmol/L)	100.0±20	108.4±18.0	120±34.0	0.0001
TBIL (µmol/L)	2.50±1.0	0.98±0.03	1.25±0.04	0.0001
TP (g/L)	70.0±5	63.40±2,8	58.6±4.50	0.0001
ALP (U/L)	20.0±7.5	11.21±55.96	6.25±11.50	0.0001
AST (U/L)	15.0±5.0	17.66±6.40	19.5±6.50	0. 0001
ALT (U/L)	5.00±2.0	5.20±1.82	6.5±0.50	0. 0001
GGT (UI/L)	10.5±5	10.80±2.50	10.00±1.50	0. 0001

Table 6: Troponin levels in horses with different cardiac diagnoses arrhythmias

Diagnosis	No. of Cases (n=114)	Troponin I (cTnI) (ng/mL) - Mean±SD	Troponin T(cTnT) (ng/mL) - Mean±SD	P value	Clinical Significance
Control group	40	0.015±0.002	0.018±0.003	Reference	Normal baseline levels
Atrial Fibrillation (AF)	60	0.110±0.025	0.095±0.02	P < 0.05	Elevated due to atrial remodeling and stress
Left Axis Deviation + LVH	29	0.075±0.015	0.080±0.018	P < 0.05	Suggests cardiac hypertrophy and strain
AV Block	34	0.065±0.01	0.068±0.012	P >0.05 (NS)	Mild troponin rise due to conduction delay
QTc Prolongation	54	0.085±0.02	0.090±0.021	P < 0.05	Increased risk of arrhythmia-related damage
ST Depression (Shock Cases)	25	0.130±0.03	0.125±0.028	P < 0.01	Suggests myocardial ischemia or hypoxia
Left Bundle Branch Block (LBBB)	13	0.095±0.022	0.102±0.019	P < 0.05	Linked to delayed conduction and structural disease
Right Bundle Branch Block (RBBB)	26	0.080±0.018	0.085±0.017	P>0.05 (NS)	Mild increase due to conduction abnormality

Results of risk factors associated with Arrhythmias indicate that the most important risk factor was breed (Arabian horses, Thoroughbred) 52.63%, age 42% horsed aged more than 10 years, performance horses 35%, electrolyte imbalance 30%, systemic hypertension 27%, shock/dehydration 18%, previous history of colic/endotoxemia 15%, use of sedatives/ anesthesia 13% (Table 7).

Table 7: The possible risk factors allied with the observed cardiac arrhythmias in the 114 horses

Risk Factor	Association with Arrhythmias	N (%)
Breed (Arabian horses, thoroughbred)	Higher prevalence of AF due to larger atrial size	60 (52.63)
Age (>10 years)	Increased risk of AF, LVH, and conduction abnormalities	42 (36.84)
Performance (Endurance, racing)	Higher cardiac workload predisposes to QTc prolongation and LVH	35 (30.70)
Hypokalemia, hypocalcemia	Prolonged QTc, ventricular arrhythmias	30 (26.31)
Systemic hypertension	Associated with LVH and left axis deviation	27 (23.68)
Shock/dehydration	ST segment depression, myocardial ischemia	18 (15.7)
Previous history of colic/endotoxemia	Inflammatory response can affect cardiac conduction	15 (13.70)
Use of sedatives/anesthetics	May contribute to QTc prolongation and bradyarrhythmia	13 (11.40)

The distribution of arrhythmias is influenced by three primary risk factors: age, breed, and sex. Among older subjects, 56 experienced arrhythmias, while only 4 did not, indicating a strong correlation between older age and the presence of arrhythmias. Conversely, in the younger group, 23 had arrhythmias, and 31 did not, suggesting a lower

likelihood of arrhythmias in this demographic. When considering the breed, a significant majority of common breeds (50 arrhythmias present) displayed arrhythmias compared to rare breeds, where only 27 exhibited them. In terms of sex, male horses exhibited a higher incidence of arrhythmias (40 cases) than females (34 cases), although both sexes had similar total populations (Table 8). The odds ratio for Older Age is 18.26 which closely indicates a strong association between arrhythmias and older aged horse. Breed and Sex also show significant associations, with odds ratios of 3.27 and 1.59 respectively (Table 9).

Table 8: Distribution of Arrhythmias in horses by Age, Breed, and Sex

Risk factor		Arrhythmias present	Arrhythmias absent	Total
Age	Older	56	4	60
	Younger	23	31	54
Breed	Common	50	14	64
	Rare	27	23	50
Sex:	Male	40	17	57
	female	34	23	57

Table 9: Odds ratios for the specified risk factors

Risk factor	Odds (Cases/Non-cases)	Odds Ratio (OR)
Age (Older)	56/4= 14	18.26
Breed (Arabian races horses)	50/13= 3.84	3.27
Sex (Male)	40/17=2.35	1.59

Discussion

The cardiac arrhythmia frequencies observed in this study indicate an increased occurrence of certain conduction abnormalities in the equine population were studied. ECG consider a gold standard for the Atrial fibrillation (AF) detection. results suggests that there may be a significant frequency of cardiac arrhythmias among the monitored population and cardiac arrhythmias are a health concern for equine practitioners Likely, the occurrence of atrial fibrillation in horses in any population will vary depending on the demographics and health characteristics of that population of horses (22). Our results indicate atrial fibrillation which is significantly higher than the 1-2% reported prevalence of AF seen in the general equine population in the previous studies (23). The increased frequency possibly due to breed, age, sport level, and underlying cardiac conditions. In 24 % of cases, left axis deviation with left ventricular hypertrophy (LVH) was diagnosed and associated with chronic cardiac remodeling, increased workload of performance horses, and systemic hypertension (24). QT prolongation was the most common abnormality occurring in 47.36% of horses, which may represent electrolyte imbalances, myocardial stress, or predisposition to ventricular arrhythmias (25,26). With increased diagnostic tools and an understanding of arrhythmia pathophysiology of diseased equine populations, it is expected that with the improvements in their prognosis, the management and prognosis of diseased equine populations will improve (27).

Additionally, left bundle branch block (LBBB) were observed in 11.40% of animals, and right bundle branch block (RBBB) in 22.81%, both of which are uncommon in healthy horses but may indicate conduction disturbance related to myocardial disease (28). ST segment depression in 17.6% of cases denotes possible myocardial ischemia or shock associated with significantly elevated cardiac troponin levels which confirms the probability of myocardial injury is higher (29). Moreover, in horses' conditions that cause first-degree AV block was found in some cases, which is generally benign but can denote high vagal tone or underlying conduction disease. Interestingly, only 34.2% of horses had a normal ECG, indicating that nearly three-quarters of the population subjects were abnormal; this reinforces the need for regular cardiac monitoring in equine practice. These findings can then be compared to general equine population data to determine that the study cohort had a significantly greater prevalence of arrhythmias than would be expected by chance (selection bias, underlying risk factors such as age and breed, environmental influences, such as training intensity and systemic health conditions). The statistical analysis showed a significant difference in troponin levels and QTc prolongation among the affected cases in terms of the clinical importance of ECG screening. Early detection and management of arrhythmias is critical in performance horses since cardiac efficiency directly influences athletic performance, and these results further emphasize the need for such. A larger sample sizes studies with and long-term follow-ups are needed to gain a better understanding of the pathogenesis of equine cardiac disease as well as any effects on the overall performance and health of the horse (30).

The hematological, biochemical, and cardiac troponin levels establish the value of the relationship between hematological and biochemical parameters and cardiac troponin levels and their role in the etiology and risk factors of arrhythmias in horses. There is a significant risk of developing arrhythmias when myocardial stress and damage become elevated particularly in conditions such as atrial fibrillation or left ventricular hypertrophy (31). The hematological parameters, including white blood cell (WBC) count and red blood cell indices, that can indicate underlying inflammatory or hypoxic conditions that can predispose horses to arrhythmias, are associated with cardiac dysfunction. Any issues in blood cell counts can have a bearing on heart functions, which is an important area of study, and the relationship between these

hematological parameters and heart arrhythmias is important. An example of this is that elevated WBC counts may signify underlying inflammation or stress that can eventually disrupt the electrical function of the heart. Likewise, changes in RBC, HGB, or HCT can contribute to poor oxygen deliverance to cardiac tissue, thus increasing the risk of arrhythmias. Currently, there are no significant differences reported based on sex, however complete hematological health needs to be assessed when a risk for arrhythmias and when the intervention to both treat heart health and overall hematological health is being tailored. These correlations still need to be further scientific investigations (32).

The biochemical abnormalities presented in these can have important implications on the risk of arrhythmias. Increased glucose could result in insulin resistance, which has been shown to cause cardiovascular dysfunction and may even be related to arrhythmias. Elevated glucose and cholesterol levels play important roles in changing metabolic conditions in the horse that may affect cardiac health and the risk of arrhythmia. Subsequently, the narrowing of blood vessels (atherosclerosis) can occur, as can poor heart blood flow leading to an irregular heart rhythm. Disturbances of minerals in soil have effect in horses which transmitted by food, that can complicate the fluid and electrolyte balance, which is important for heart function especially if urea and creatinine are high. These biochemical shifts make metabolic health a trigger for monitoring and metabolic health strategies, whether or not populations are at risk for cardiac arrhythmias, alongside strategies of heart rhythm stability (33).

Structural and functional cardiac abnormalities, along with the prevalence of disturbances of electrical conduction, as left bundle branch block and QTc prolongation, are evidence for the major effects of structural and functional cardiac abnormalities on equine arrhythmias (34,35). Additionally, hematological and biochemical profiles between healthy and arrhythmic horses are very clear, validating these parameters as useful tools for screening horses susceptible to developing cardiac problems. Taken together, the hematological, biochemistry, and troponin data of the combination thereof help to understand what type of pathology of the arrhythmia of the horse and approach the risk factors and prevalence and interventions to improve the hematological health of the horse's heart. Designing effective preventative and therapeutic strategies to limit the effects of arrhythmias in the equine population will rely on further research on these interrelationships (36).

Conclusion

Horses used for performance frequently have cardiac arrhythmias, Nevertheless, are much more common in older individuals, furthermore, according to breeds, arrhythmias are more likely occur in Arabian than thoroughbred horse, and are more common in males than in females. On the other hand, ECG with the aid of biochemical evaluation considered as the standard gold method for early and accurate diagnostic tool, However, ongoing monitoring is required to understand their clinical importance and prognosis.

Acknowledgment

The authors of this paper are deeply grateful to the University of Mosul, College of Veterinary Medicine, for there assistant and cooperation. Naturally, we have to keep in mind the owner's involvement.

Conflict of interest

None.

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تقييم اضطرابات نظم القلب لدى الخيول

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الخلاصة

تعد اضطرابات تخطيط كهربائية القلب من الحالات الشائعة في خيول السباق والتي قد توثر بشكل معنوي على أداء هذه الحيوانات. هدفت الدراسة الى تحليل نتائج تخطيط كهربائية القلب وتحديد تكرار اللانظمية القلبية، أجريت الدراسة خلال الفترة من ايلول ٢٠٢٣ الى اب ٢٠٢٤ تم الحصول على تسجيل تخطيط كهربية القلب القياسي من جميع الخيول، تم اجراء فحص الدم والكيمياء الحيوية فضلا عن قياس التروبونين القلبي. اظهرت النتائج ان من بين ١١٤ حصانا بالغا ضعيف الأداء، سُجّلت ٤٠ حالة لم تعاني من اضطراب نظم القلب عدت كمجموعة سيطرة في حين أربعة وسبعون (٦٤,٩%) من الخيول مصابة بنوع واحد على الأقل من اضطراب نظم القلب، ولوحظ رجفان أذيني في ٦٠ حالة (٥٢,٦٣%)، بينما عانى ٢٩ حصانا (٢٥,٤٤%) من انحراف المحور الى اليسار وتضخم البطين الأيسر. وكان أكثر اضطراب في التوصيل شيوعا هو الحصر الأذيني البطيني في ٣٤ حالة (٢٩,٨٢%)، يليه إطالة فترة QT في ٥٤ حصانا (٤٧,٣٦%)، ثم إطالة فترة QTc في ٥٠ حصانا (٤٣,٨٥%). كما ظهر تباطئ القلب في ٢٠ حالة (١٧,٥٤%)، ووجود انخفاض في القطعة ST في ٢٥ حصانا (٢١,٩٣%). اضطرابات التوصيل، بما في ذلك حصر الحزمة اليسرى لدى ١٣ حصانا (١١,٤٠%) وحصر الحزمة اليمنى لدى ٢٦ حصانا (٢٢,٨١%). ارتفعت مستويات التروبونين بشكل ملحوظ في حالات عدم انتظام ضربات القلب. وكان معدل الإصابة بالرجفان الأذيني أعلى بشكل ملحوظ لدى الخيول الذكور في جميع الفئات العمرية باستثناء الخيول الأكبر سنا. ونظرا لأن عدم انتظام ضربات القلب قد يؤدي إلى عدم تحمل خيول السباق للتمارين، وانخفاض أدائها، فإن التشخيص المبكر مهم لتمكين الأطباء البيطريين من وضع استراتيجيات علاجية طويلة الأمد. علاوة على ذلك، يُعد تخطيط كهربية القلب، إلى جانب فحص مؤشر التروبونين القلبي، أمرا بالغ الأهمية.