Atrial fibrillation in two healthy Chianina cows

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SUMMARY

Atrial fibrillation is a cardiac arrhythmia which frequently occurs in human and veterinary medicine. This arrhythmia has been reported in cattle and it is commonly recorded in animals affected by underlying cardiac diseases or in association with gastrointestinal disease, abdominal pain, metabolic diseases and electrolyte disturbances. Idiopathic atrial fibrillation has been also described in apparently healthy Holstein dairy cows with an incidence of 2.5%. The aim of this report is to describe for the first time the presence of primary and persistent atrial fibrillation in two Chianina cows without underlying diseases detected using routine diagnostic tests. The cows, apparently healthy, were examined for a disturbance of the heart rhythm in a farm of central Italy. Electrocardiographic examination confirmed the presence of atrial fibrillation with ventricular response rate of 80 bpm in both cows. Transthoracic echocardiography showed no structural heart diseases; results of the hematological and serum biochemical profile were unremarkable. No increase in troponin I concentration was revealed. Both cows were rechecked in a period of 14 months and no changes were observed at the physical and electrocardiographic examination. Both cows delivered a healthy calf during this period without calving difficulties or health problems. Based on the history, clinical findings and outcome, atrial fibrillation in both cows was considered primary and persistent in absence of underlying diseases. Being the heart rate in normal limits during the period of observation, treatments were not recommended. Atrial fibrillation can occur in healthy Chianina cows with no apparent underlying diseases and without compromising the reproductive performance. Evaluation of arrhythmias in cows can be a diagnostic challenge for veterinarians because of not-practical use of standard electrocardiographic machines, cables, and electrodes in field. However, new portable devices can be more easily available in farm and they can provide useful information for the diagnosis and prognosis in affected cattle.

KEY WORDS

Arrhythmias; cattle; electrocardiogram; heart.

INTRODUCTION

Atrial fibrillation (AF) is a cardiac arrhythmia which frequently occurs in humans and animals. This arrhythmia can be classified as primary (also termed idiopathic or lone) in absence of underlying cardiac diseases detected using routine diagnostic tests; however, AF can also be associated with underlying cardiac disease. In cattle, this arrhythmia is the most commonly recorded in animals affected by underlying cardiac diseases or gastrointestinal diseases (abomasal displacement and dysfunction of forestomachs)[1-6]. Atrial fibrillation has also been observed in apparently healthy Holstein dairy cows with an incidence of 2.5%[7]. To the authors' knowledge, limited studies have reported idiopathic atrial fibrillation in other cattle breeds[1].

The Chianina is an Italian cattle breed selected for its high-quality meat and it is present in different territories of the world (Italy, North and South America, Australia). This breed is the largest and one of the oldest cattle breeds in the World. However, the scientific literature about cardiac diseases in Chianina cows is scarce[8,9].

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Therefore, this report aims to describe the presence of primary and persistent AF in two Chianina cows without demonstrable clinical, echocardiographic and laboratory findings of disease.

CASES PRESENTATION

Two female Chianina cows were examined for a disturbance of the cardiac rhythm in a farm of central Italy (Umbria). The referring veterinarian had revealed a cardiac arrhythmia during a routinary clinic visit and had requested a specialistic evaluation to the veterinary cardiology service of the Department of Veterinary Medicine of Perugia University.

The case 1 was a 7-year-old Chianina cow in 7th month of gestation, which showed heart rate of 80-90 bpm with irregular rhythm and without any other abnormalities at the physical examination. Cow was born in the farm and there was no history of disease prior to presentation or evidence of it during previous routinary visits. The standard base-apex ECG examination (ECG-1101G VET 5-lead, Carewell health care, Shenzhen, China) was acquired positioning the positive electrode caudally to the olecranon, at the level of the 5th left intercostal space, and the negative electrode on the left jugular furrow in the lower 1/3 of the neck, as previously described[10]. The other electrodes

were attached near the negative electrode. To obtain a good quality of the ECG tracing, a small amount of alcohol was used to optimize the contact. The ECG tracing showed absence of P waves, irregular RR interval, normal QRS morphology and undulation of the baseline ('f' waves). These electrocardiographic findings were suggestive of AF with ventricular response rate of 80 bpm (Figure 1). Transthoracic echocardiography was performed using an ultrasound unit equipped with multifrequency 1-4 MHz phased-array transducer (MyLab 30 Gold, Esaote, Genova, Italy), and standard echocardiographic images were obtained from the left and right hemithorax[11]. Six two-dimensional parasternal images were obtained from the right hemithorax and three two-dimensional parasternal images from the left hemithorax[11]. Additionally, a M-mode image of the left ventricle were obtained from the right parasternal short-axis view and Doppler studies were performed on all cardiac valves. Transthoracic echocardiography showed no structural heart diseases. Blood sample was obtained for hematological and serum biochemical profile. Electrolyte determinations and troponin I concentration were also evaluated. Results of the hematological and biochemical profile as well as serum electrolyte determinations and troponin I concentration were unremarkable (Table 1). Based on the history, clinical, electrocardiographic, echocardiographic and laboratory findings, AF in the cow was considered primary in absence of underlying diseases and no treatments were made.

The case 2 was a 9-year-old, not-pregnant, Chianina cow, which showed heart rate of 80-85 bpm with irregular rhythm. The remaining physical examination was unremarkable. Cow was born in the farm and there was no history of disease prior to presentation or evidence of it during previous routinary visits. The electrocardiographic examination (performed as described in case 1) was suggestive of AF with ventricular response rate of 80 bpm (Figure 1). Transthoracic echocardiography (performed as described in case 1) showed no structural heart diseases. Blood sample was obtained for hematological and serum biochemical profile, electrolyte determinations, and troponin I concentration. No significant abnormalities were observed (Table 1). Based on the above reported findings, AF in the cow was considered primary in absence of underlying diseases and no treatments were made.

Both cows were reevaluated 1, 3, 6, 10 and 14 months later and no changes were observed at the physical and electrocardiographic examination (Figure 2). Being the heart rate in normal limits during this period of observation, treatments were not recommended. Both cows delivered a healthy calf during this period without calving difficulties or health problems.

DISCUSSION

Our report demonstrates for the first time the presence of AF in Chianina cows without demonstrable clinical, echocardiographic and laboratory findings of an underlying disease. As previously described in Holstein dairy cows[7], primary and persistent AF can occur also in apparently healthy Chianina cows.

Atrial fibrillation can be categorized as paroxysmal, persistent

Table 1 - Hematological and serum biochemical parameters of the two Chianina cows affected by atrial fibrillation.

Hematological parameters	Case 1	Case 2	Reference limits[a]
WBC (10^3/µl)	6.57	6.01	4-12
RBC (10^6/µl)	7.86	6.98	5-10
HGB (g/dl)	11.7	9.5	8-15
HCT (%)	38.29	32.54	24-46
PLT (10^3/µl)	273	240	100-800
Biochemical parameters			
AST (U/L)	68	77	60-125
GGT (U/L)	14	16	6-17.4
CK (U/L)	173	129	0-350
Bilirubin (mg/dl)	0.08	0.04	0-1.6
Glucose (mg/dl)	69	69	40-100
Creatinine (mg/dl)	1.82	1.85	0.5-2.2
Phosphorus (mg/dl)	7.4	6.5	5.6-8
Total protein (g/dl)	7.2	7.3	6.7-7.5
Albumin (g/dl)	3.7	3.6	2.5-3.8
Calcium (mg/dl)	8.1	9.4	8-11.4
Magnesium (mg/dl)	2.5	2.9	1.5-2.9
Potassium (mmol/L)	4.5	4.5	>3.6
Sodium (mmol/L)	146	145	136-144
Chloride (mmol/L)	107	104	99-107
Troponin I (ng/ml)	0.01	0.02	<0.08

[a] www.merckvetmanual.com

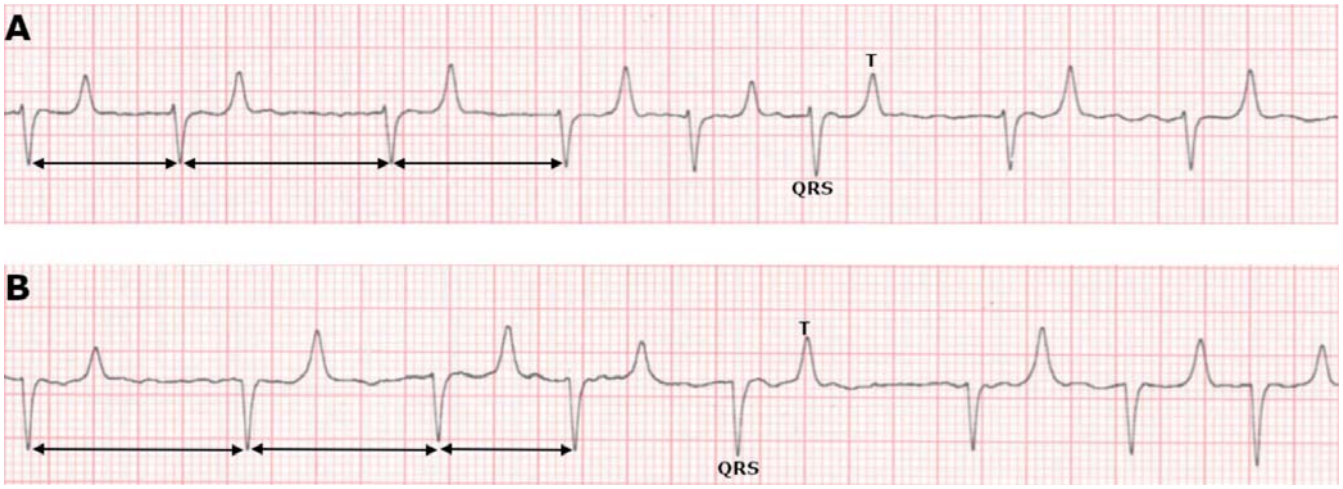

Figure 1 - Electrocardiographic tracings recorded in the two Chianina cows affected by atrial fibrillation. Absence of P waves, irregular RR intervals (double-headed arrows), normal QRS morphology and undulations of the baseline ('f' waves) are evident in both electrocardiograms. Heart rate is 80 bpm in both electrocardiograms. Paper speed = 25 mm/s; gain = 10 mm/mV. A=case 1; B=case 2

or permanent depending on the duration of the arrhythmia: paroxysmal AF spontaneously disappears within 24-48 h; persistent AF converts to sinus rhythm only after treatment, whereas permanent AF is sustained and resistant to therapy. Moreover, AF can be classified in primary (no evident cardiac diseases) or secondary to underlying cardiac diseases. In human and veterinary medicine, patients affected by primary AF will have the ventricular rate close to normal or only slightly increased because of low sympathetic tone when standing. Otherwise, patients with structural heart diseases will have the heart rate increased because of high sympathetic tone necessary to maintain cardiac output and arterial blood pressure. In the cows of this report, AF was classified primary and persistent because no evident cardiac diseases can be identified, and the arrhythmia was recorded in the following rechecks with a heart rate in the reference limits for this species. Machida et al. (1993) have described the presence of primary AF in 7 Holstein cows that were found among 285 Holstein dairy cattle without clinically demonstrable disease[7]. In 4 of these 7 cases, the condition was classified as paroxysmal because lasted for a short period (few days from the onset) and

Figure 2 - Electrocardiographic and phonocardiographic tracings recorded in a cow (case 2) with atrial fibrillation 14 months after the diagnosis of cardiac arrhythmia. (A) Electrocardiogram and phonocardiogram simultaneously recorded by Eko DUO ECG + Digital Stethoscope. Absence of P waves, irregular RR intervals, positive QRS complexes and undulations of the baseline are evident in the electrocardiogram. S1= first heart sound; S2=second heart sound. Paper speed = 25 mm/s; gain = 20 mm/mV. (B) Electrocardiogram recorded by 1-lead ECG eKuore. Absence of P waves, irregular RR intervals (double-headed arrows), normal QRS morphology and undulations of the baseline ('f' waves) are evident in the electrocardiogram. Heart rate is 80 bpm. Paper speed = 25 mm/s; gain = 10 mm/mV.

spontaneously converted to normal sinus rhythm. Authors speculated that the arrhythmia can be related to high sympathetic activity accompanying parturition as well as increased vagal tone associated with reduced food intake[7]. The other 3 cows showed a persistent form of AF which remained throughout the observation period (> 9 months). Authors speculated that an increased load imposed on the heart, associated with milk production, could be the causative factor of the development of AF, as the arrhythmia occurred at the stage of the peak milk production[7]. In our Chianina cows affected by primary AF, the onset of AF was unknown and if parturition or management factors could cause the onset of the AF, remains undetermined. However, these factors have been previously described as cause of paroxysmal forms of AF which spontaneously converted in normal sinus rhythm[7]. Moreover, the suspected causative factors for persistent AF in the Holstein cows were the changes on the heart associated with milk production[7]. Increased sympathetic stimulation and the influence of lactation on the intracardiac dimensions could have a causal role in the development of AF in dairy cows[3,12]. However, these specific conditions have not been reported in beef breed and cannot be applicated to the Chianina breed.

In cattle without structural heart diseases, AF is most commonly recorded in association with gastrointestinal diseases, abnormalities causing abdominal pain, metabolic diseases, and electrolyte disturbances (e.g., acute enteritis, left displacement of the abomasum or torsion of uterus)[1-5]. A combination of heightened excitation of the atrial myocardium, electrolyte and acid-base disturbances or change in vagal tone can represent the cause of the development of the AF in cattle[1-5]. The arrhythmia usually converts spontaneously to sinus rhythm with correction of the underlying disorder, in absence of clinically detectable cardiac lesions[1-5]. Some authors have previously described histopathological findings in 9 Holstein cows affected by idiopathic AF: large or multifocal areas of myocardial fibrosis, mainly localized in the upper portion of the anterolateral and medial regions of the right atrium, were observed with greater severity in cattle with AF than healthy controls (cows in sinus rhythm)[13]. Unfortunately, if these lesions were the result of sustained AF or they could have a role in the genesis of the arrhythmia, remains unknown[13]. Clinical, echocardiographic and laboratory findings in our Chianina cows were not associated with any underlying cardiac o systemic disease: if histopathological cardiac lesions were present as consequence of the AF or if they played a causative role for the onset of the arrhythmia, remains undetermined.

Electrocardiographic examination is routinely performed by a simple base-apex lead system in cattle and it is mainly used for the assessment of arrhythmias[14]. Recently, the use of smartphone electrocardiographic devices has been reported in horses and healthy cows for evaluation of heart rate and rhythm in hospital as well as in field[15-18]. Moreover, these devices allow to overcome the not-practical use of a standard ECG machine, cables, and electrodes in field. In the cows of this report, two of these new portable devices (Eko DUO ECG + Digital Stethoscope, Oakland, CA, USA; 1-lead ECG eKuore, Chip Ideas Electronics SL, Spain) were used to recheck and confirm the persistence of AF in farm with a good accuracy (Figure 2).

In conclusion, we described clinical and electrocardiographic findings in two Chianina cows affected by AF without demonstrable clinical, echocardiographic and laboratory features of disease. Atrial fibrillation can occur in healthy Chianina cows with no apparent underlying diseases and without compromising the reproductive performance, as described in our report. Evaluation of arrhythmias in cows can be a diagnostic challenge for veterinarians, although new portable devices can be more easily available in farm and they can provide useful information for the diagnosis and prognosis in affected cattle.

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Conflict of Interest

The authors declare that there were no conflicts of interest.

References

1. Brightling P., Townsend H.G.G. (1983). Atrial fibrillation in ten cows. Can Vet J, 24: 331-334.
2. McGuirk S.M., Muir W.W., Sams R.A., Rings D.M. (1983). Atrial fibrillation in cows: clinical findings and therapeutic considerations. J Am Vet Med Assoc, 182: 1380-1386.
3. Constable P.D., Muir W.W., Bonagura J.D., Rings D.M., Jean G. (1990). Clinical and electrocardiographic characterization of cattle with atrial premature complexes. J Am Vet Med Assoc, 197: 1163-1169.
4. Rezakhani A., Oloumi M.M., Ahmadinia R. (1996). Atrial fibrillation in a cow with fetal maceration. Can Vet J, 37: 625-626.
5. Jafari Dehkordi A., Nasser Mohebi A., Heidari Soreshjani M. (2014). Frequency of cardiac arrhythmias in high- and low- yielding dairy cows. Vet Res Forum, 5: 1-5.
6. Caivano D., Marchesi M.C., Boni P., Passamonti F., Venanzi N., Lepri E. (2021). Mural Endocarditis and Embolic Pneumonia Due to Trueperella pyogenes in an Adult Cow with Ventricular Septal Defect. Vet Sci, 8: 318. doi: 10.3390/vetsci8120318.
7. Machida N., Nakamura T., Kiryu K., Kagota K. (1993). Electrocardiographic features and incidence of atrial fibrillation in apparently healthy dairy cows. J Vet Med 40: 233-239.
8. Caivano D., Marchesi M.C., Boni P., Venanzi N., Angeli G., Porciello F., Lepri E. (2021). Double-outlet right ventricle in a Chianina calf. Animals 11, 318. doi: 10.3390/ani11020318.
9. Jacinto J.G.P., Häfliger I.M., Caivano D., Drögemüller C. (2022). A germline de novo variant in NUMB associated with a double-outlet right ventricle in Chianina cattle. Anim Genet, 53: 713-714. doi: 10.1111/age.13236.
10. Rezakhani A., Paphan A.A., Shekarfroush S. (2004). Analysis of base apex lead electrocardiograms of normal dairy cows. Vet Arhiv, 74: 351-358.
11. Hallowell G.D., Potter T.J., Bowen I.M. (2007). Methods and normal values for echocardiography in adult dairy cattle. J Vet Cardiol, 9: 91-98. doi: 10.1016/j.jvc.2007.10.001.
12. Zarifi M., Buczinski S., Rezakhani A., Mokhber Dezfouli M.R., Khonsha A. (2012). Effect of lactation on functional and morphological echocardiographic variables in adult dairy cows. J Vet Cardiol, 14: 415-421. doi: 10.1016/j.jvc.2011.11.009.
13. Machida N., Kiryu K. (2001). Cardiac lesions in dairy cows with idiopathic atrial fibrillation. J Vet Med Sci, 63: 873-878. doi: 10.1292/jvms.63.873.
14. Buczinski S., Rezakhani A., Boerboom D. (2010). Heart disease in cattle: Diagnosis, therapeutic approaches and prognosis. Vet J, 184: 258-263. doi: 10.1016/j.tvjl.2009.05.005.
15. Bonelli F., Vezzosi T., Meylan M., Nocera I., Ferrulli V., Buralli C., Meucci V., Tognetti R. (2019). Comparison of smartphone-based and standard base-apex electrocardiography in healthy dairy cows. J Vet Intern Med, 33: 981-986. doi: 10.1111/jvim.15396.
16. Corradini I., Fernández-Ruiz A., Barba M., Engel-Manchado J. (2020). Stall-side screening potential of a smartphone electrocardiogram recorded over both sides of the thorax in horses. J Vet Intern Med, 34: 2101-2108. doi: 10.1111/jvim.
17. Alberti E., Stucchi L., Pesce V., Stancari G., Ferro E., Ferrucci F., Zucca E. (2020). Evaluation of a smartphone-based electrocardiogram device accuracy in field and in hospital conditions in horses. Vet Rec Open, 7: e000441. doi: 10.1136/vetreco-2020-000441.
18. Vitale V., Vezzosi T., Tognetti R., Fraschetti C., Sgorbini M. (2021). Evaluation of a new portable 1-lead digital cardiac monitor (eKuore) compared with standard base-apex electrocardiography in healthy horses. PLoS One, 16: e0255247. doi: 10.1371/journal.pone.0255247.