Case report: atrial fibrillation in a 9-day old calf with diarrhoea

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SUMMARY
Irregularity of the heart rhythm was diagnosed during a routine cardiac auscultation in a 9 day old diarrheic calf and subsequently characterized as atrial fibrillation by electrocardiography. No structural heart disease was diagnosed on further examination but changes in the electrolyte balance, particularly a marked hyperkaliemia, was evidenced. After antibiotic treatment and correction of the electrolyte disequilibrium, the atrial fibrillation has disappeared. In this clinical case, it is probable that severe diarrhoea has lead to hyperkaliemia which in turn has induced a functional atrial fibrillation.

Keywords: Atrial fibrillation, calf, functional lesion, diarrhoea, hyperkaliemia.

Introduction
Atrial fibrillation (AF) is an arrhythmia which was first identified in 1909 [15]. It is a cardiac arrhythmia characterized by a lack of coordinated atrial electrical activity [16]. The modern era of our understanding of this arrhythmia begins with the hypothesis of Moe and Abildskov [12], suggesting that AF is the result of multiple atrial random re-entrant waves [11]. Most human patients with AF have structural heart disease often leading to dilation of the atria. Large clinical trials have identified atrial dilation as an independent risk factor for the development of AF. Furthermore, an elevated intra-atrial pressure will increase the atrial wall stress, which may result in local intra-atrial conduction disturbances [6].

In most species, atrial fibrillation usually results from underlying cardiac diseases. The onset of AF requires an additional triggering factor, such as alteration of autonomic tone, acute or chronic changes in atrial wall tension, atrial ectopic foci or other local factors [7]. In cattle, AF is the most common dysrhythmia, the diagnosis of which can only be confirmed by ECG [3]. Cattle with atrial fibrillation usually have gastrointestinal disease, although foot rot, pneumonia, mated foetus and endocarditis have also been associated with AF [13, 14]. Anorexia and decreased milk production are common in cattle with this disorder.

Although AF is considered as relatively common in cattle and has been frequently described in this species, a review of veterinary literature shows no report of this condition in calves. In the present report, a case of AF in calf with diarrhoea has been recorded and discussion of the clinical findings has been presented.

Case report
HISTORY
A 9-day-old male calf was diagnosed with cardiac irregularities during a routine examination after the onset of diarrhoea. The calf had severe diarrhoea with dehydration estimated to 8%. The severity of the diarrhoea was assessed by the method described by CONSTABLE et al. [5]. In this method which is the most accurate for assessing dehydration in calves eyeball recession into orbit (degree of enophthalmos), skin tent duration in the neck region, and plasma protein concentration are considered as best indicators of the degree of dehydration (Table I).

CLINICAL FINDINGS
The calf exhibited moderately to severely disturbed general behaviour and condition, anorexia and a markedly reduced skin surface temperature. The rectal temperature was 37.4°C, and its heart and respiratory rates were 73 beats/minute and
40 breaths/minute, respectively. The patient had severely increased skin tent and sunken eye.

Initial identification of cardiac arrhythmia was made on routine auscultation of the heart. In addition to irregularities of rate and rhythm, variations in amplitude of the heart sounds were also heard. Variations in pulse amplitude and the occurrence of pulse deficit were detected by simultaneous palpation of the pulse of the median artery on the caudo-medial aspect of the carpus.

Confirmation of the atrial fibrillation (AF) was made by electrocardiography using a bipolar base-apex lead I with the calf standing up (figure 1A). The P waves were absent and were substituted by a series of rapid irregular low voltage oscillations (F waves) and some extra-systoles were also evidenced.

Blood sample was collected by jugular vein puncture into a sterile tube without anticoagulant. After clotting at room temperature for 30 minutes, the sample was centrifuged (1 500g, room temperature, 15 minutes) and serum was carefully harvested and stored at -20°C until analysis in order to evaluate the electrolyte concentrations. In parallel, the haematocrit value was determined immediately after the blood puncture by microhaematocrit centrifugation. It was observed a slight increase in the haematocrit value (42%, usual values: 35 ± 3% [16]) coupled to marked decreases in the serum Na and Ca concentrations and to increases in the K and Mg concentrations (Table II).

Conversion to normal sinus rhythm (figure 1B) and normal electrolyte concentrations were seen after routine treatment with 2.2 mg/kg BW daily cobactan (Cefquinome, Intervet Schering-Plough Animal Health, Boxmeer, the Netherlands) for 3 days) as antibiotics and intravascular administration of isotonic fluids (Lactated Ringer (Shahid Ghazi, Tabriz, Iran), 4 L) to resolve the primary condition of diarrhoea.

**Table I: Guidelines for assessment of hydration status in calves with diarrhoea according to CONSTABLE et al. [5].**

<table>
<thead>
<tr>
<th>Dehydration</th>
<th>Behaviour</th>
<th>Eyeball Recession</th>
<th>Skin tent duration (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5%</td>
<td>Normal</td>
<td>Non</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>6%-8% (mild)</td>
<td>Slightly depressed</td>
<td>2-4 mm</td>
<td>1-2</td>
</tr>
<tr>
<td>8%-10% (moderate)</td>
<td>Depressed</td>
<td>4-6 mm</td>
<td>2-5</td>
</tr>
<tr>
<td>10%-12% (severe)</td>
<td>Comatose</td>
<td>6-8 mm</td>
<td>5-10</td>
</tr>
<tr>
<td>&gt; 12%</td>
<td>Comatose / Death</td>
<td>8-12 mm</td>
<td>&gt; 10</td>
</tr>
</tbody>
</table>

**Discussion**

Gastrointestinal disorders have been associated with atrial fibrillation in adult cattle [13]. In cattle, vagal nerve tone disturbances have been suggested as the cause of AF, a condition usually coupled to gastrointestinal problems. However, in the calf, no cases of AF have so far been reported.

In humans, however, re-entrant circuit waves are recently proposed as the main cause of the disease [11] and large size of the heart chambers have been proved to predispose the heart to AF [1]. This condition is mostly frequent in man with chronic structural heart diseases or in aged animals. Large heart chambers are not a regular finding in calf except if a congenital heart disorder in which heart murmur is audible over the defective area exists. Nevertheless, in this case report, no heart murmur on several auscultations before and after the treatment was found. The presence and absence of primary heart diseases have been used to distinguish two distinct forms of AF which has been named “organic” and “functional”, respectively [2]. Functional or alone atrial fibrillation may be due to fibrotic areas in the atrium that predispose patients to

**Figure 1:** Electrocardiographs (Modified lead I., paper speed 25 mm/second; sensitivity 1 cm/mV) performed on the 9 day old calf exhibiting diarrhoea before (A.) and after treatment with antibiotics including cobactan (2.2 mg/kg BW) and isotonic fluids including lactated Ringer (B.). In the first graph (A.), note the absence of the P wave, the presence of F waves (arrows) and extra-systole (arrowhead) whereas the second graph (B.) was normal (Note the presence of P waves (arrow)).
arrhythmia, to increased susceptibility to autonomic neural stimuli to the heart [4] or to localized atrial myocarditis [8]. Although structural heart disease underlies many cases of AF, the pathogenesis of AF in apparently normal heart is less well understood. While in people there is considerable overlap, pulmonary vein triggers may play a dominant role in younger patients with relatively normal hearts and short paroxysms of AF, whereas an abnormal atrial tissue substrate may play a more important role in patients with structural heart disease and persistent or permanent AF [10]. Consequently, when AF is diagnosed, cases in which cardiac pathology is the primary cause must be differentiated from cases where other primary conditions are present. No structural heart abnormality was identified in this case, although no echocardiography examination was performed. In addition, no abnormal heart murmur was detected on auscultation that might indicate congenital heart diseases for further echocardiography investigation. Returning to normal rhythm after treatment of the main complaint (diarrhoea) suggests that there was no basic structural heart condition; therefore the case report may be a case of functional AF.

Abdominal pain in diarrhoea may directly stimulate the branches of sympathetic nerves innervating the heart or may increase the release of catecholamines [2]. This situation may enhance the autonomy of the heart and increase the opportunity for arrhythmia to develop. Abdominal pain is almost always present in calves with diarrhoea but it is exceptionally associated to AF, suggesting that other causes than the abdominal pain are involved in the AF development. Another important factor in the induction of functional AF may be hyperkalemia. Indeed, hyperkalemia is known to induce bradycardia or can even stop sino-atrial (SA) nodal firing [9] and decreased SA node firing may open up opportunity for other sites in the atria or pulmonary branches to initiate re-entrant circuits resulting in atrial fibrillation. In the clinical case reported here, a marked hyperkalemia probably caused by diarrhoea was observed and would contribute to the functional AF occurrence.

As a conclusion, a functional AF was diagnosed in a 9 day old calf with profuse diarrhoea and was probably due to hyperkalemia. However, further investigations are required for evaluating the functional AF prevalence and elucidating its exact causes in diarrheic calves.

Acknowledgment

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**Table II:** Serum electrolyte concentrations in a 9 day old calf exhibiting diarrhoea coupled to atrial fibrillation.

<table>
<thead>
<tr>
<th>Electrolyte</th>
<th>Na (mEq/L)</th>
<th>K (mEq/L)</th>
<th>Ca (mmol/L)</th>
<th>Mg (mmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case report</td>
<td>103</td>
<td>10</td>
<td>1.02</td>
<td>1.146</td>
</tr>
<tr>
<td>Usual values [13]</td>
<td>132-152</td>
<td>3.9 - 5.8</td>
<td>2.43-3.10</td>
<td>0.74-1.10</td>
</tr>
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**References**