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CARDIAC ARRHYTHMIAS IN CANINE PATIENTS WITH RENAL INSUFFICIENCY

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ABSTRACT

The aim of the present retrospective study was to define the main types of cardiac arrhythmias and their prevalence in dogs with renal insufficiency. The survey included 20 patients at various age, sex and breed with III, IV and V stage of acute or chronic kidney failure. The total prevalence of arrhythmias in the studied canine group was 25% (5/20). Discussion of the possible etiology of the recorded electrocardiographic changes was performed.

Key words: ECG, arrhythmia, canine, renal insufficiency.

Introduction

Renal insufficiency is a clinical syndrome accompanied with various water, electrolyte, acid-base, hormonal, hematological and cardiovascular alterations. Scientific view about acute kidney failure (acute kidney injury (AKI)) has changed over recent years from single organ failure syndrome to complex disorder where the kidneys play active role in the progress of multi-organ dysfunction (Makris and Spanou, 2016). Chronic kidney insufficiency (chronic kidney disease (CKD)) is characterized by progressive and irreversible decline of nephron function and the outcome is largely dependent on the presence of concomitant cardiac pathology (Bartges, 2012).

Long-standing truth is that kidney disease is a risk factor for development of cardiovascular disease (Sarnak et al., 2003) and vice versa. A widespread cardiac disorder like chronic mitral valve disease is associated with increased prevalence of CKD (Martinelli et al., 2016). Patients with AKI or CKD are prone to development of ventricular arrhythmias (Bonato and Canziani, 2017). The increasing time of ventricular depolarization and repolarization, determined by measuring the QT interval on the electrocardiogram, could emerge as a predictor of ventricular arrhythmias in human cardiology (Bignotto et al., 2012).

Cardio-renal syndrome is defined as a broad spectrum of diseases where both the heart and kidneys are involved in an acute or chronic setting (Ronco and Di Lullo, 2014). Also in veterinary medicine the close links between kidneys and hearth in pathological states are in active process of definition (Keller et al., 2016; Pouchelon et al., 2015).

Materials and methods

Study animals – twenty (n=20) dogs with acute or chronic kidney disorder were included. The animals were from different breeds (German Shepherd dog, n=2, Miniature Pincher, n=2, Doberman Pincher, n=2, Bull Terrier, n=2; Pit bull, n=1; Riezenschnauzer, n=1; mongrel dogs, n=10). Mean age was 10.2 years (range 3 to 16 years), mean body weight was 19.2 kg (range 3 to 50 kg), male dogs, n= 12, female, n=8. Main inclusion criterion was serum creatinine level (above 250 μmol/l for all animals), i.e. patients in III to IV stage of AKI and III to V stage of CKD were included (Cowgill, 2016; IRIS, 2019). (tabl.1). Forty-five percent (9/20) were with AKI and 55%

(11/20) with CKD. Patients were chosen from the canine population of a Small Animal Clinic in Sofia, Bulgaria.

Table 1: Stages of AKI and CKD in dogs according to IRIS (2016, 2019)

Stage	AKI – Blood creatinine µmol/l	CKD – Blood creatinine µmol/l
1	< 140	< 125
2	141–220	125–250
3	221–439	251–440
4	440–880	>440
5	> 880	–

Mean results of the biochemical renal and some of the electrolyte parameters of the studied patients were as follows: Creatinine – 740.13 µmol/l (range 224 to 2711.9 µmol/l), Urea – 27.59 mmol/l (range 7.37 to 55 mmol/l), K^+ – 7.19 mmol/l (range 3.70 to 16.33 mmol/l), Ca^{++} – 1.72 mmol/l (range 0.43-2.83 mmol/l), P – 3.79 mmol/l (range 1.99 to 5.89). Hyperkalemia was detected in 55 % (11/20) of the tested dogs.

ECG recording – the electrodes were placed in forelimbs and hindlimbs according to Tilley (1992), in standing position or right lateral recumbency without sedation. The six frontal plane leads were recorded at a velocity of 50 mm/s (1 mm = 0.1 mV, 1 mm = 0.04 s).

Results

The total prevalence of arrhythmias in the studied canine group was 25 % (5/20). Recorded arrhythmias were of supraventricular and ventricular origin. The first were represented by atrial standstill with accelerated idioventricular rhythm (fig.1) and atrial fibrillation with prevalence of 5% (1/20) each and the second one - with ventricular premature complexes (VPCs) – 5% (1/20) and ventricular tachycardia (VT) – 10% (2/20) (Fig. 2). Three of the positive dogs were male and two - female. The mean age of the animals with arrhythmias was 11.4 years (range 3 to 16 years).

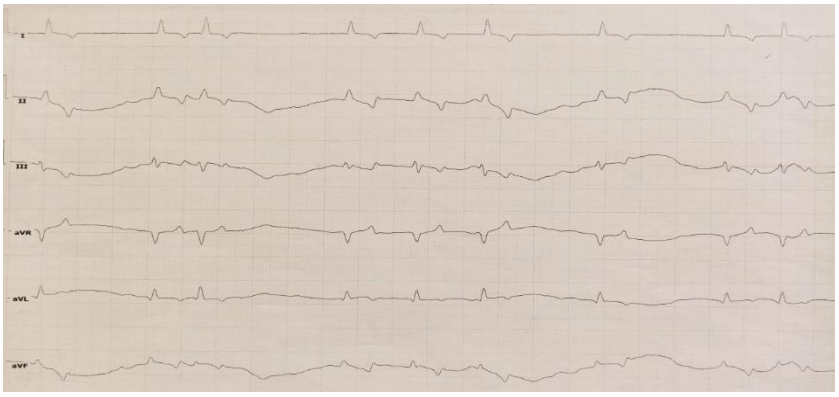

Figure 1: Atrial standstill with accelerated idioventricular rhythm in a 14 years old mongrel dog in III stage of CKD; K^+ – 7.89 mmol/l (50 mm/s, 10 mm/mV, HR – 114 bpm)

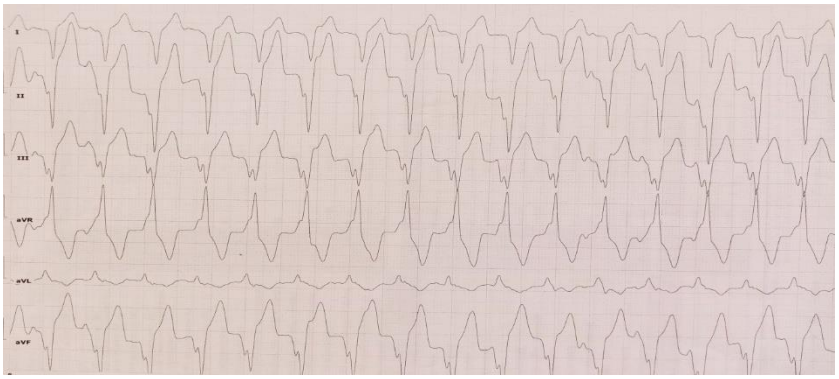

Figure 2: VT in a 8 years old Bull Terrier dog in IV stage of AKI; K^+ – 6.84 mmol/l (50 mm/s, 10 mm/mV, HR – 208 bpm)

Discussion

Ventricular extrasystole is a premature ectopic heartbeat (VPCs) originating in the ventricles. An episode of three or more consecutive ectopic ventricular complexes, associated with a heart rate higher than 100 bpm is referred to as ventricular tachycardia (VT) which can lead to syncope or cardiac arrest (Qu and Weiss, 2015). Atrial standstill is a disorder of the cardiac rhythm that involves the complete absence of electrical atrial activity and is commonly associated with some type of idioventricular rhythm (Correa-Salgado and Pérez-Zapata, 2019). An accelerated idioventricular rhythm is characterized by a ventricular rate that is slow or comparable to a normal sinus rate (60 to 150 bpm in the dog) (Vassalle et al., 1977). Hyperkalemia is a prominent factor causing atrial standstill (Gul et al., 2012). Atrial fibrillation is defined as rapid and irregular beating of the atrial chambers (Brundel et al., 2005).

To the best of our knowledge there are no recent published data concerning the arrhythmia prevalence in dogs with kidney disorders.

It is well defined that even mild reductions in kidney function can alter the electrophysiological properties of the myocardium and increase the risk of ventricular arrhythmias and sudden cardiac death. In the particular case potassium, sodium, calcium and magnesium level monitoring is essential (Mozos, 2014). Hyperkalemia especially which can be severe in patients with kidney disorders and have detrimentally negative impact (Green et al., 2013). The mean serum potassium level of the patients in our study was 7.19 mmol/l and 55% of all were with hyperkalemia.

Arrhythmia etiology in kidney disorders remains unclear. An experimental rat model of CKD investigated some of the possible electrophysiological events which can lead to arrhythmia nascency, e.g. action potential prolongation, increased electrical instability, frequent early depolarization, changes in intracellular calcium homeostasis, with reduction of calcium content in the sarcoplasmic reticulum (Hsueh et al., 2014).

Conclusion

Cardiac arrhythmias represent an integral component of the cardio-renal syndrome. According to the available data and to our results these can be of supraventricular and ventricular origin and exactly the ventricular tachycardia may lead to cardiac arrest. Electrolyte disturbances, especially hyperkalemia, are defined as loading factor for arrhythmia generation in such patients. Therefore, their timely and accurate ECG diagnosis and persistent serum electrolyte monitoring should be in

the focus of attention.

References

1. Bartges J. (2012). *Chronic kidney disease in dogs and cats*. The Veterinary Clinics of North America. Small Animal Practice 42, 669–692.
2. Bignotto L., Kallás M., Djouki R., Sassaki M., Voss G., Soto C., Frattini F., Medeiros F. (2012). *Electrocardiographic findings in chronic hemodialysis patients*. J Bras Nefrol. Jul-Sep; 34(3):235–42.
3. Bonato F., Canziani M. (2017). *Ventricular arrhythmia in chronic kidney disease patients*. J Bras Nefrol. Apr–Jun; 39 (2):186–195.
4. Brundel B., Melnyk P., Rivard L., Nattel S. (2005). *The pathology of atrial fibrillation in dogs*. J Vet Cardiol; 7:121–129.
5. Correa-Salgado R., Pérez-Zapata J. (2019). *Four-Year Follow-Up Persistent Atrial Standstill in a Dog*. Israel Journal of Veterinary Medicine, Vol. 74 (2), 102–107.
6. Cowgill L. (2016). *International Renal Interest Society (IRIS)*. Grading of acute renal injury, 1–9.
7. Green D., Green H., New D., Kalra P. (2013). *The clinical significance of hyperkalaemia-associated repolarization abnormalities in end-stage renal disease*. Nephrol Dial Transplant. Jan; 28(1):99–105.
8. Gul E., Erdogan H., Yıldırım O., Soylu A., Nikus K. (2012). *Hyperkalemia-Induced Accelerated Idioventricular Rhythm in a Patient with Acute*. Renal Failure, 34:4, 543–544.
9. Hsueh C-H., Chen N., Lin S-F., Chen P-S., Gattone V. 2nd, Allen M., Fishbein M., Moe S. (2014). *Pathogenesis of Arrhythmias in a Model of CKD*. Am Soc Nephrol; 25:2812–21.
10. International Renal Interest Society (IRIS). (2019). *IRIS staging of CKD*. 1–5.
11. Keller S., Kovacevic A., Howard J., Schweighauser A., Francey T. (2016). *Evidence of cardiac injury and arrhythmias in dogs with acute kidney injury*. JSAP, Volume 57, Issue 8, 402–408.
12. Makris K., Spanou l. (2016). *Acute Kidney Injury: Definition, Pathophysiology and Clinical Phenotypes*. Clin Biochem Rev 37 (2), 85–98.
13. Martinelli E., Locatelli C., Bassis S., Crosara S., Paltrinieri S., Scarpa P., Spalla I., Zanaboni A., Quintavalla C., Brambilla P. (2016). *Preliminary Investigation of Cardiovascular–Renal Disorders in Dogs with Chronic Mitral Valve Disease*. J Vet Intern Med; 30:1612–1618.
14. Mozos I. (2014). *Laboratory Markers of Ventricular Arrhythmia Risk in Renal Failure*. Biomed Res Int. 2014: 509204.
15. Pouchelon J., Atkins C., Bussadori C., Oyama M., Vaden S., Bonagura J., Chetboul V., Cowgill L., Elliot J., Francey T., Grauer G., Luis Fuentes V., Sydney Moise N., Polzin D., Van Dongen A.,Van Israël N. (2015). *Cardiovascular–renal axis disorders in the domestic dog and cat: a veterinary consensus statement*. J Small Anim Pract. Sep; 56(9): 537–552.
16. Qu Z., Weiss J. (2015). *Mechanisms of Ventricular Arrhythmias: From Molecular Fluctuations to Electrical Turbulence*. Annu. Rev. Physiol. 77:29–55.
17. Ronco C., Di Lullo L. (2014). *Cardiorenal syndrome*. Heart Failure Clinics; 10(2):251–280.
18. Sarnak M., Levey A., Schoolwerth A., Coresh J., Culleton B., Hamm L., McCullough P., Kasiske B., Kelepouris E., Klag M., Parfrey P., Pfeffer M., Raij L., Spinosa D., Wilson P. (2003). *Kidney disease as a risk factor for development of cardiovascular disease: a statement from the American Heart Association Councils on Kidney in Cardiovascular Disease, High Blood Pressure Research, Clinical Cardiology, and Epidemiology and Prevention*. Hypertension. Nov; 42(5):1050–65.
19. Tilley L. (1992). *Essentials of canine and feline electrocardiography*. 3rd Edn., Philadilphia, Lea and Febiger. 1–252.
20. Vassalle M., Knob R., Cummins M., Lara G., Castro C., Stuckey J. (1977). *An Analysis of Fast Idioventricular Rhythm in the Dog*. Downloaded from http://ahajournals.org by on April 7, 2020.