PREVALENCE OF ARTERIAL HYPERTENSION IN CATS WITH DIFFERENT PATHOLOGIES

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Abstract
The objective of this study is to establish the prevalence of hypertension in a group of cats and highlight the importance of the measurement of blood pressure routinely during the initial clinical exam within veterinary medicine. The study of the pathogenesis of hypertension by differentiating primary from secondary hypertension while detailing the diseases with which it is associated. In contrast to humans, essential or idiopathic hypertension is rare in veterinary patients. In cats, systemic hypertension is most often associated with another disease or condition such as: kidney failure, disease, hyperadrenocorticism, hyperthyroidism, pheochromocytoma, primary hyperaldosteronism, diabetes mellitus and obesity.
Key words*: arterial hypertension, cats, prevalence, kidney failure*

Introduction

Systemic hypertension is an increasingly diagnosed disorder in dogs and cats and frequently occur secondary to chronic kidney disease. Prevention of damage to organs such as the kidneys, brain, heart, and eyes is one of the primary concerns in the management of veterinary patients with hypertension. Hypertension can be classified as primary (essential) or secondary. Essential hypertension refers to hypertension for which the cause remains unknown after extensive diagnostic testing, whereas secondary hypertension is associated with underlying disease or administration of hypertensive agents. In cats and dogs, systemic hypertension is most often associated with another disease or condition such as: renal disease, hyperadrenocorticism, hyperthyroidism, pheochromocytoma, primary hyperaldosteronism, diabetes mellitus and obesity.

Materials and methods

This population includes a total of 52 cats consulted for various reasons in three veterinary hospitals in Lebanon (LeVéto-Jounieh and Véto-Beirut during the years 2014-2015 and Healthy Pet Hospital-Byblos during the years 2016-2018). The cats in this group are aged on average 12.5 years old. The youngest cats are 8 years old while the oldest is 20 years old. 19% of animals (9 cats) are under 10 years old and 81% (43 cats) are 10 years old and over. Persian cats and crossbreeds of the same breed dominate the picture in this group. 33% of cats (17 cats) are Persians while 10% of cats (10%) are crossbreeds of the Persian breed . 21% of cats (11/52) are of undetermined breed.

Artherial blood pressure measurements are performed indirectly using the Doppler method, which has the advantages of being the most used in practice, simple to handle, inexpensive and whose reliability and reproducibility of measurements are already confirmed and demonstrated.

Complementary examinations

Examination of fundus of the eye: using an ophthalmoscope, using the technique of indirect ophthalmoscopy without pupillary dilatation.

Biochemical blood tests: they contain the following dosages: urea, creatinine, glutamic pyruvic transaminase, alkaline phosphatase and glucose. These tests are performed by 2 different machines depending on availability: Reflotron® Plus and Fuji DRI-CHEM NX500i.

Ultrasound examinations: Abdominal ultrasound is established to evaluate all abdominal organs, especially the digestive system, kidneys and liver (shape, size, and echogenicity), the presence of abdominal masses that may correspond to adrenal tumors or ganglia hypertrophied. Two machines have been used Mindray DC-vet and Mindray DP 6900 vet, with probes at 7.5-10 MHz.

Echocardiographic examinations are performed when the clinical examination showed a cardiovascular disorder such as a heart murmurs identified during auscultation. A Mindray DC-3vet color doppler machine was used.

Urine exams. Urinary density was measured using a refractometer for veterinary use. Urine strips were taken to detect glycosuria for the diagnosis of diabetes mellitus and to identify the presence of ketonuria and thus a complication of ketoacidosis. Examination of urinary sediment after centrifugation of urine, for the search for crystals, cells (epithelial cells, red blood cells, leucocytes, etc.), cylinders and bacteria (during a urinary infection).

Results and discussions

15 different pathologies are diagnosed. Chronic kidney disease (CKD) is the dominant pathology followed by heart disease. In what follows, we will focus on studying the diseases diagnosed in our study in cats and with whom the arterial hypertension **(**HTA) is generally associated. This is CKD, heart disease and adrenal tumors.

Chronic kidney disease (CKD)

62% (32 cats) suffered from CKD, of which 50% (16 cats) suffered from other concomitant diseases. Cardiac disorders were most cases followed by polycystic kidney disease. Two cats suffered from both CKD and asthma. Two cats presented tumors visualized on the abdominal ultrasound. A cat had a mass detected in the spleen and other cat had a metastatic masses affecting several abdominal organs and resulted in the euthanasia. Other cat was presented suffering from dysphagia following a dental fracture.

Characteristics of the cat population suffering from CKD

It has 32 cats as the total number. Males represent approximately 62.5% of the CKD (20/32) cat population, of which 65% (13/20) are sterilized, females represent 37.5% of cats with CKD (12/32) of which 50% (6/12) are sterilized. The average age is 12.65 years old, the youngest is 8 years old, the oldest is 20 years old. Persian cats (P) were the most cases suffering from CKD (12/32) if we add Persian crossbreeds (PX) we will have 44% of the population (14/32 cats), 19% of cats (6/32) for each of the European breeds (E) and gutter (G), three Himalayan cats (H), 2 siamese cats (S) and one angora cat (A) (Table 1).

Symptoms. 93.8% of these cats with CKD (30/32) presented lethargy and / or anorexia, 65.6% of cats (21/32) had polyuria and polydipsia, 40.6% (13/32) presented vomiting, 40.6% (13/32) had halitosis. Only 12.5% of cats (4/32) had diarrhea. On clinical examination dehydration was the most common symptom, observed in 93.8% of cases (30/32), weight loss and bad condition of the coat were also symptoms that have affected a large majority of subjects 87.5 % of cats (28/32). Hypothermia was found in 28.1% of cases (9/32 cats). A heart murmur was identified in 25% (8/32 cats) of cats. Retinal haemorrhages are signs of hypertension and were found in 15.6% of cats (5/32).

Serum urea. The normal values of uremia in cats are between 13 and 30 mg/dl. Thirty or 94% of this population are uremic (uremia greater than 30 mg/dl).

Serum creatinine. 59.4% of cats (19/32) are in stage 2 according to the IRIS classification (creatinemia 1.6 - 2.8 mg/dl), 31.3% of cats (10/32) are in stage 3 (creatinemia 2.9-5) and 9.4% of cats (3/32) in stage 4 (creatinine $\geq$5).

Table 1

Results of 32 cats with chronic kidney disease (CKD)

Nº	**Breed**	**Age** (years)	**Sex***	**SABP** (mmHg)	**Creat** (mg/dl)	**Uree** (mg/dl)	**Urinary Density**	**RCPU**	**HT (%)**
1	P	13	M(s)	140	2.3	52.8	1.035	0.06	N
2	P	14	M(s)	130	2.5	65.8	1.029	0.02	N
3	P	12	F(e)	170	3.4	67.5	1.020	0.2	20%
4	E	12	M(s)	200	3.4	75.8	1.015	1.2	20%
5	P	12	M(e)	150	1.9	48	1.040	0.1	N
6	H	13	F(e)	210	5.8	>140	1.018	0.88	20%
7	G	9	F(e)	120	2.1	22	1.035	0.1	N
8	Px	8	F(s)	150	7.6	>140	1.007	-	N
9	P	9	M(s)	150	2.5	49.2	1.020	-	N
10	E	16	M(s)	120	2.0	36.8	1.037	-	N
11	H	12	M(s)	230	7.5	140	1.010	-	19%
12	G	13	F(s)	160	3.5	85	1.018	-	N
13	G	10	M(s)	250	3.2	140	1.022	-	19%
14	Px	16	M(s)	180	2.5	127	1.035	-	N
15	P	13	F(e)	190	4.2	120	1.018	-	18%
16	A	12	M(s)	150	2.8	78	1.030	-	N
17	E	20	M(s)	130	1.9	50	1.040	-	N
18	S	12	F(s)	195	2.7	80.6	-	-	N
19	P	14	M(e)	125	1.8	85	-	-	N
20	E	10	M(s)	120	2.1	61	-	-	N
21	G	14	F(e)	130	2.3	70.5	-	-	N
22	P	12	M(s)	170	1.9	72.6	-	-	N
23	P	11	M(e)	130	3.6	124	-	-	N
24	G	11	F(s)	120	2.2	69	-	-	N
25	P	12	M(e)	120	3.1	>140	-	-	N
26	P	16	F(s)	120	2.3	72.6	-	-	N
27	P	13	F(e)	120	2.1	>140	-	-	N
28	E	16	F(s)	120	2.1	128	-	-	N
29	E	11	M(s)	120	1.8	21.5	-	-	N
30	G	9	M(s)	120	2.3	46	-	-	N
31	S	11	M(e)	210	4.8	139	-	-	18%
32	H	14	M(e)	190	3.8	115	-	-	20%

*s =sterilized; SABP = systolic artherial blood pressure; RCPU= ratio "proteinuria: creatinuria"

Urinary density was measured in seventeen cats in this population. About 35% of cats (6/17) have hyperphenyluria (DU≥1035 g / ml), 53% of cats (9/17) have minimum density limit (DU 1012-1035 g / ml) and 12% (2/17) have hypo-sthénurie. The results are presented in table 1.

The ratio "proteinuria: creatinuria" RCPU is calculated in 7 cats out of 32 cats. Two cats showed a result greater than 0.4. A cat have results between 0.2 and 0.4 and the last 4 (57%) have a result less than 0.2. The results are grouped in table 1.

The hematocrit. A formula count was performed at all 32 cats. 25% of cats, 8/32, presented with anemia (HT less than 28%). The results are presented in table 1. The letter N will be used for cats with normal hematocrit (HT 28-49%).

Measurement of systolic artherial blood pressure (SABP) were performed on 32 cats. To have the precise number of cats suffering from hypertension, twenty-one of these cats were the subject of several measurements (series of 2 or 3 measurements) either to confirm normal values of PA in dehydrated animals after rehydration and thus eliminating false negatives either, to confirm high PA values and eliminate false positives. 34.4% of the total number of cats with CKD

(1/32) are hypertensive. Systolic arterial pressures ranged from 170 to 250 mmHg. Five cats had a systolic blood pressure greater than 200 mmHg. The results are presented in table 1.

Renal ultrasonography in 32 cats with CKD. 34.4% of cats with CKD (11/32 had abnormal kidney function, including seven smaller than normal kidney cats (<3cm) and / or hyperechoogens on ultrasound (Fig. 1, 2), three cats had polycystic kidneys (Fig. 3) and a cat had tumor kidneys.

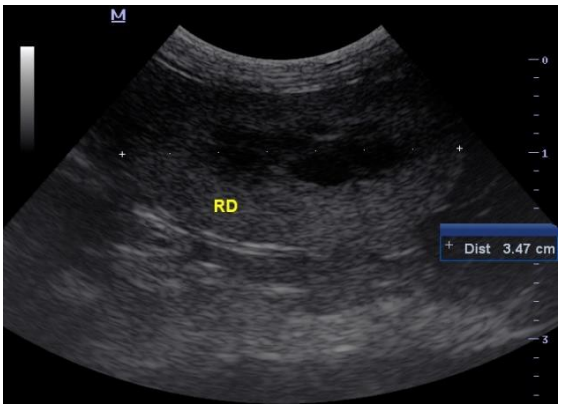

Fig. 1. Ultrasonography of the right kidney of a cat with CKD showing a hyperechoic kidney

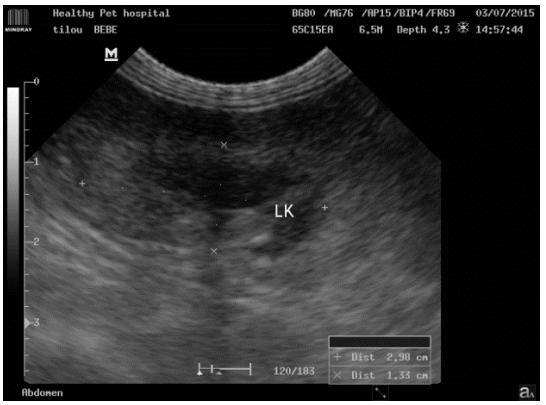

Fig. 2. Ultrasonography of the left kidney of a cat with CKD showing an unusually small kidney

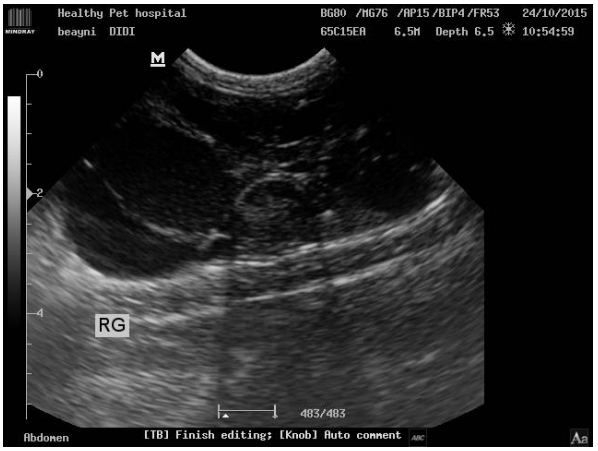

Fig. 3. Ultrasonography of the left kidney of a cat with CKD showing a polycystic kidney

Since the conclusive race and sex predispositions of feline CKD are still not reported in the literature (9), and although Persian cats are predisposed to polycystic kidney disease (8, 9, 10, 13), other studies that need to be conducted on a larger population will be needed to confirm if males are more predisposed to CKD compared to females and to see if the Persians are the most predisposed since this breed is overrepresented in our study.

Similarly, 4 cases of CKD (20%) suffered concurrently from a cardiac pathology (left ventricular hypertrophy, thickening of the inter ventricular septum and free wall of the left ventricle) determined by echocardiography, on the other hand, the cause and effect relationship of

these two conditions is not determined since both pathologies were diagnosed at the same time. Finally, 70% of this population (14 of 20 cats) are normotensive, which confirms that many cats with CKD have normal blood pressure at the time of diagnosis and may never develop systemic hypertension, even if they are renal impairment (4, 12, 15). So our study reconfirms that in felines, HTA is most often associated with CKD (6, 11, 12).

Heart diseases. 23.1% of cats (12/52) had a heart condition (23%) of the population, 10 of 12 were presented because of lethargy and / or anorexia, of which 9 had concomitant disease.

Characteristics of the cat population suffering from heart disease. Males represented 58.3% of cats with heart disease (7/12) and 21.2% of the total male population (7/33) of which 57.1% are sterilized. Females represented 41.7% of cats with heart disease and about 26.3% of the total female population (5/19), 40% of which are sterilized. The average age is 13 years old, the youngest is 8 years old, the oldest is 17 years old. Persian cats dominate the chart of cats suffering from heart diseases (6/12) if we add Persian crossbreeds we will have about 66.7% of the population is (8/12 cats). The two Siamese cats in our study are also part of this group.

Complementary exam results in cats with heart disease (Table 2). Eight of the eleven cats also have CKD, one of which also has adrenal tumors (TS). The last 3 do not have concomitant diseases. A heart murmur ≥ grade 2 was audible on auscultation in all 12 cats. The results were presented in table 2. Cardiac echocardiography was performed in all cats that presented a heart murmur intensity ≥ 2/6. Eleven of the twelve cats (about 92%) had Hypertrophic Cardiomyopathy (HCM) (Fig. 4), one with pre-aortic stenosis and one with an obstruction of the left ventricular outflow tract. The twelfth cat presented aortic stenosis (AS) with diastolic dysfunction.

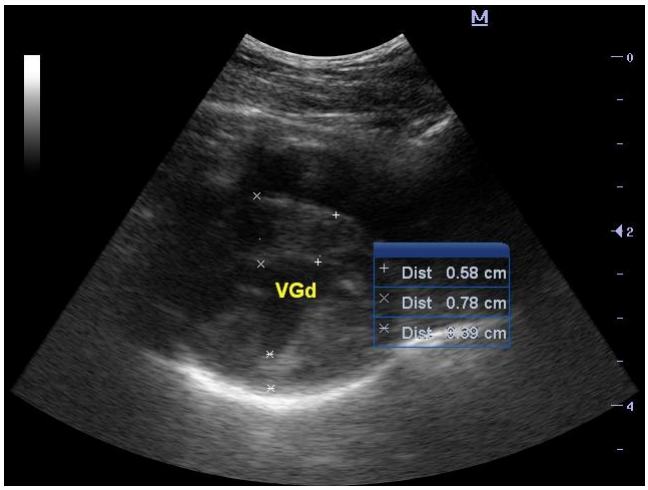

Fig. 4. Echocardiography of one of 12 cats showing left ventricular hypertrophy

Results of the SABP of cats suffering of heart disease. 50% of cats with heart disease (6/12) have high blood pressure, of which five cats have concomitant CKD, and the sixth has bilateral adrenal tumors on abdominal ultrasound. None of the 3 cats with only heart disease presented arterial hypertension. (Table 2).

Table 2.

Systolic artherial blood pressure (SABP) in cats with heart disease

N°	**Breed**	**Age** (years)	**Sex***	**SABP** (mmHg)	**Heart disease**	**Concomitant pathology**
1	P	13	M(s)	140	HCM	CKD
2	Px	16	M(s)	180	HCM	CKD
3	Px	8	F(s)	150	HCM	CKD
4	S	12	F(s)	195	HCM	CKD
5	G	10	M(s)	250	HCM	CKD
6	P	16	F(s)	120	HCM	CKD
7	S	11	M(e)	210	HCM	CKD
8	H	14	M(e)	200	HCM	CKD
9	P	16	M (s)	220	HCM	Adrenal tumor
10	P	13	M(e)	140	HCM	-
11	P	10	F(e)	135	HCM	-
12	P	17	F(e)	145	AS	-

*s =sterilized; HCM =Hypertrophic cardiomyopathy; AS=aortic stenosis; CKD= chronic kidney disease;

Hypertrophic cardiomyopathy (HCM) is the dominant disease. It is characterized by symmetrical or asymmetrical concentric hypertrophy of the posterior wall of the left ventricle and / or the interventricular septum. The 3 cats at the same time suffering from CKD showed arterial hypertension. In these cats, cardiac involvement may be a consequence of high blood pressure (LOC). On the other hand, confirmation of this hypothesis is impossible (heart disease may exist before HTA).

Adrenal tumors A single Persian sterilized male, 16 years old, presented ocular and subcutaneous hemorrhages. A heart murmur is audible on auscultation. PA intake revealed systolic hypertension of 220 mm Hg. Fundus eye examination revealed complete right retinal hemorrhage with retinal detachment and left vitreous hemorrhage. Echocardiography revealed symmetrical hypertrophic cardiomyopathy (Fig 5).

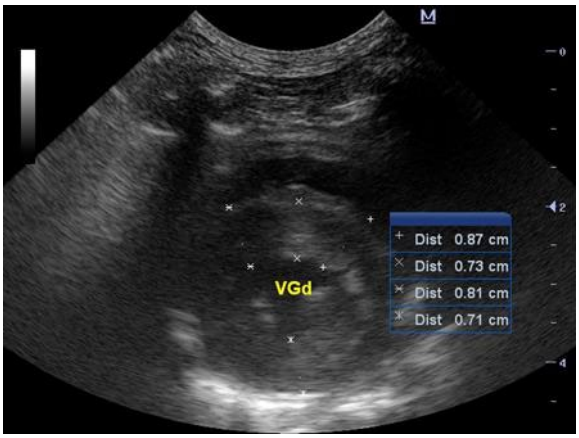

Fig. 5. Echocardiography showing symmetrical hypertrophy (7-9 mm) of the left ventricle

The echography of the 2 eyeballs was performed to evaluate the internal structures and the degree of lesions in the right eye retinal detachment was found while a hematoma was present in the vitreous of the left eye (Figures 6 and 7).

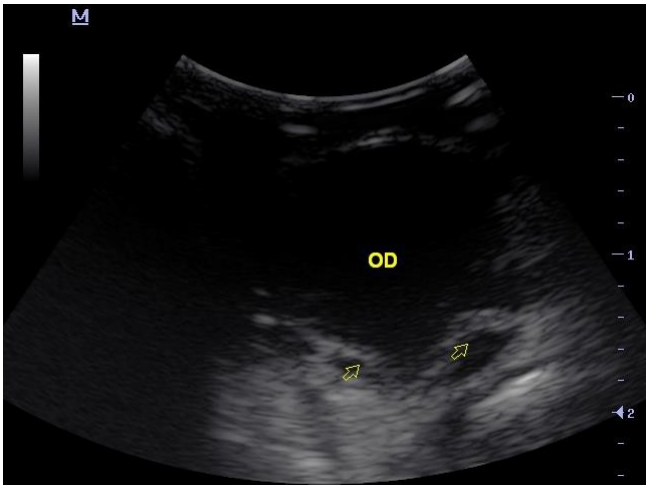

Fig 6. Ultrasound of the right eye showing retinal detachment (arrows)

Fig 7. Ultrasound of the left eye showing a hematoma 0.85 cm in diameter

Abdominal ultrasound revealed a bilateral adrenal tumor (figures 8 and 9). Primary adrenal tumors are reported in about 0.03% of cats (5). About half of the adenomas and adenocarcinomas are mineralized; pheochromocytomas are rarely mineralized (16). The plasma and urine concentrations (over 24 hours) of catecholamines and their metabolites (metanephrine, normetanephrine, and vanillylmandelic acid) are regularly measured in humans, and high concentrations strongly support the diagnosis of pheochromocytoma (1). These tests are not readily available for dogs and cats, and even results are reported ambiguous in a dog (2) so their usefulness in veterinary medicine is still not determined.

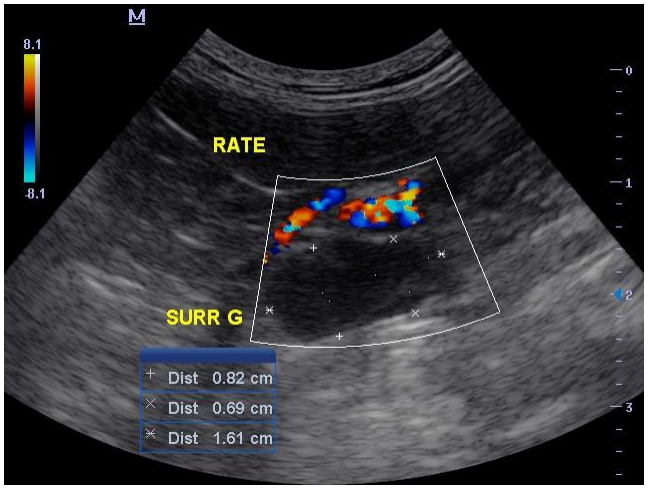

Fig 8. Ultrasonography of the left adrenal gland showing a mass of 0.82 cm in diameter

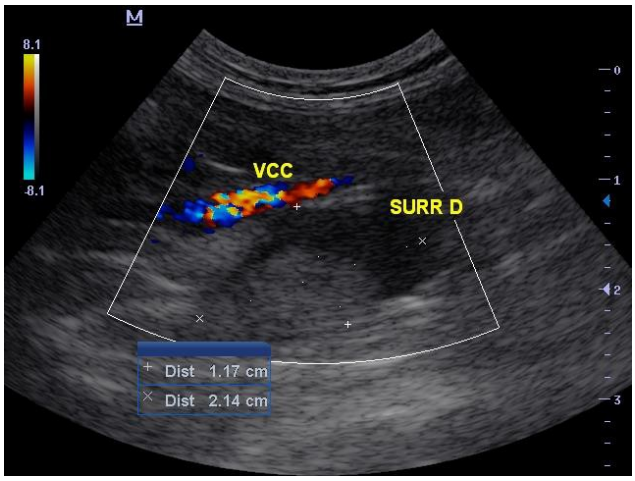

Fig 9. Ultrasonography of the right adrenal gland showing a mass of 1.17 cm in diameter

Systolic artherial blood pressure (SABP) was analysed to all 52 cats under the conditions described above, with 37.5% (12/32) of cats exhibiting SABP greater than 160 mmHg (Table 3), the vast majority (11 / 12) suffers from CKD alone or associated with other pathologies and only one has a bilateral adrenal tumor (Table 3). Primary hypertension was not diagnosed in our study, which confirms that it is very rare in cats (3) and that a primary cause must always be sought before classifying a hypertension in the cat as initial or idiopathic .

Six of twelve hypertensive cats (50%) presented evidence of hypertensive retinopathy in the form of bilateral retinal hemorrhages and retinal detachment in 3 cases. In all 6 cats, blood presure was greater than 200 mm Hg. Six of twelve hypertensive cats (50%) presented evidence of cardiac disease as a result of hypertrophic cardiomyopathy.

Table 3

Characteristics of hypertensive cats

Nr	Breed	Age (years)	Sex	SABP (mmHg)	Associated pathologies
1	P	12	F(e)	170	CKD+Polycystic kidney disease
2	PX	16	M(s)	180	CKD+Heart disease
3	E	10	M(s)	250	CKD+Heart disease
4	H	12	M(s)	230	CKD+Heart disease
5	H	12	F(e)	205	CKD+Polycystic kidney disease
6	E	12	M(s)	200	CKD
7	P	13	F(e)	190	CKD
8	S	12	F(s)	195	CKD+Heart disease
9	P	12	M(s)	170	CKD
10	S	11	M(e)	210	CKD+Heart disease
11	H	14	M(e)	190	CKD+Heart disease
12	P	15	M(s)	220	Adrenal tumor/Heart disease

Conclusions

1. High blood pressure is a pathological entity still under diagnosed in veterinary medicine. The prevalence of high blood pressure is high among cats with CKD and heart disease.
2. Our study demonstrates the relatively high prevalence of target organ damage including eyes and heart and the importance of diagnosis and early management of hypertension.
3. Despite all the progress in the diagnosis of high blood pressure in cats and dogs, a small number of clinics have the necessary equipment to take blood pressure, so this study, proves that importance of the diagnosis of hypertension and justifies the need to possess the necessary equipment for this purpose and to master his technique.

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