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The Use of Nutri-Plus Gel® in Cardiology

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Abstract: Appropriate nutritional management is indispensable to ensure the quality of life in animals suffering from heart diseases. Complementary feeds, still little used in veterinary medicine but increasingly employed in humans, represent a worthwhile option for the nutritional management of animals with heart diseases. Nutri-Plus Gel® is a complementary feed composed of high-energy ingredients (glucose syrup, soybean oil and cod liver oil), hydrolyzed animal proteins, vitamins and oligo-elements. Due to its high-energy content and excellent palatability, Nutri-Plus Gel® is used for nutritional recovery and convalescence in dogs and cats. It is also used during periods of high-energy requirement and intense physical effort (e.g. hunting season, sled-dog races…). This collection of cases illustrates 5 routine clinical situations encountered in veterinary cardiology in which the use of a palatable high-energy complementary feed is of practical value. These situations include facilitation of restraint during an examination (e.g., echocardiography), promoting treatment compliance (notably during long-term multitherapy), and providing nutritional support during periods of lack of appetite associated with advanced heart diseases and post-operative recuperation. In any case, complementary feed should always be used as a complement to the appropriate diet, rather than a replacement of the later.
Keywords: veterinary cardiology, Nutri-Plus Gel®, high energy, nutritional support, low appetite.

INTRODUCTION

The nutritional management of pet animals with chronic diseases has now become routine practice in veterinary medicine. Owners are increasingly aware of the consequences, and importance, of a diet suited to their pet's condition. The important role of nutrition in the development and treatment of many animal diseases is now well-established. Thus, pet food companies have been developing lines of "therapeutic kibble" for use in different medical fields (dermatology, uro-nephrology, gastro-enterology or even cardiology) for several decades, although in 2002 fewer than one out of 5 diseased dogs or cats was being fed diet food (19% and 18%, respectively) [1].

The connection between diet and cardiology is well-known in humans and animals. Diet-based heart diseases have thus been described in both dogs and cats, e.g., dilated cardiomyopathy related to taurine deficiency in dogs and cats, and L-carnitine deficiency in dogs [2]. Additionally, advanced heart diseases, especially right-sided ones, are often accompanied by cachexia which has a poor prognosis and may even necessitate euthanasia [3]. Monitoring of nutritional status, and appropriate adaptation of the food ration, are therefore indispensable to manage and ensure the quality of life in animals suffering from heart diseases. However, for various reasons inherent to both owners and their animals, few cardiac dogs (less than 5% in 2003) are receiving food that is adapted to their heart disease [4].

Complementary feeds, still little used in veterinary medicine but increasingly employed in humans for their nutritional virtues and physiological effects,represent another worthwhile option for the nutritional management of animals with heart diseases [4, 5].

This collection of five specific cases illustrates the value of using a palatable complementary feed, i.e., Nutri-Plus Gel®[a], in different practical situations in cardiology. This product is composed of high-energy ingredients (glucose syrup, soybean oil and cod liver oil), hydrolyzed animal proteins, vitamins and oligo-elements. Due to its high-energy content and excellent palatability, Nutri-Plus Gel®[a] is used for nutritional recovery and convalescence in dogs and cats. It is also used during periods of high-energy requirement and intense physical effort (e.g. hunting season, sled-dog races…).

CASE REPORT 1

A 7 year-old, 950 g castrated male ferret was referred to the cardiology department for acute restrictive dyspnoea associated with lethargy and cough which had progressed over the last week. The fur was dull and spiky on physical examination. The rectal temperature was normal (38.2°C). The mucous membranes were pink and capillary refill time was two seconds. Examination of the respiratory tract evidenced tachypnoea (respiratory rate >60 breaths/minute) and diffuse inspiratory crackles were heard during the lung field auscultation. Moreover, regular tachycardia was detected (heart rate could not be calculated), associated with a left apical grade III/VI systolic heart murmur and a left basal grade III/VI diastolic heart murmur. The femoral arterial pulses were symmetrical and synchronous with the heart beats. The remainder of the clinical examination was unremarkable.

The association of heart murmurs, tachycardia, restrictive dyspnoea and inspiratory crackles during lung field auscultation first suggested a left-sided congestive heart failure (CHF) with pulmonary oedema, as the two left heart murmurs (systolic at the apex and diastolic at the base) were consistent with double valve insufficiency (i.e., mitral and arterial valves).

Due to the severe respiratory distress, oxygen therapy was begun on admission, and a loop diuretic (furosemide[b]) was injected intramuscularly at a dose of 2 mg/kg. Thoracic radiographs were obtained as soon as the dyspnoea had become less marked, and evidenced cardiomegaly (vertebral heart score = 6, [reference range (RR) = 3.75-4.07] [6, 7]) as well as numerous alveolar patterns, consistent with diffuse alveolar pulmonary oedema (Figure 1).

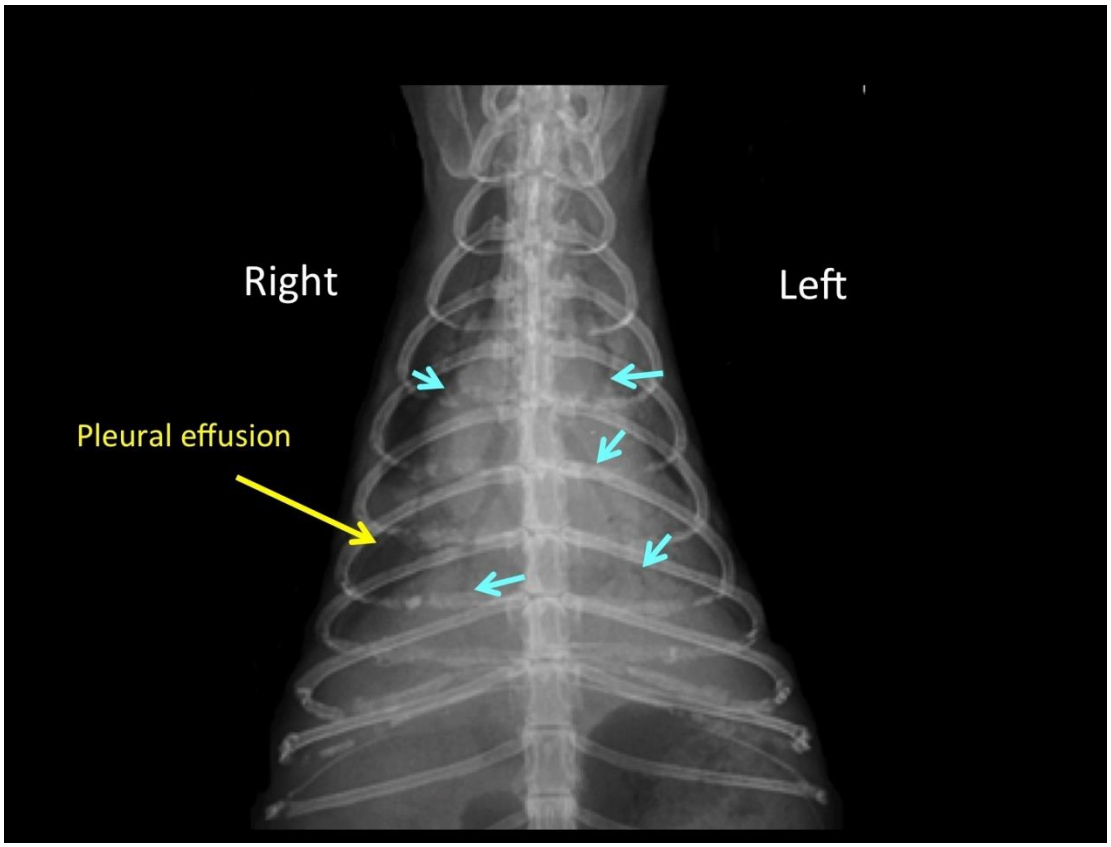

Fig-1: Ventrodorsal radiograph demonstrating alveolar patterns (arrows), consistent with a cardiogenic pulmonary oedema based on clinical findings. Photo: Diagnostic Imaging Department of ENVA

They also showed a pleural line between the middle and caudal right pulmonary lobes, suggestive of pleural effusion. Transthoracic echocardiography was then recommended to confirm or rule out the hypothesis of decompensated heart disease. To facilitate restraint of the animal and enable the operator to perform the echocardiography under optimal conditions (reduction of movements and stress), a highly palatable complementary feed (Nutri-plus Gel®[a]) was given orally and continuously throughout the examination (Figure 2).

Fig-2: Restraint of the ferret with Nutriplus Gel®[a] during the echocardiograhic examination. Photos: Alfort Cardiology Unit

Echocardiography and Doppler examination confirmed the presence of pleural effusion and evidenced severe systolic mitral regurgitation (Figure 3), which explained the left apical systolic murmur detected during auscultation, with a maximal area of the regurgitant jet area signal to left atrium area ratio of 84% (assessed using the colour Doppler mapping technique on the right parasternal four-chamber view). Continuous-wave and colour-flow Doppler modes also revealed an aortic insufficiency extending to the apex of the left ventricle, and explaining the left basal diastolic heart murmur. This aortic insufficiency was considered severe, as the aortic regurgitant jet height to aorta width ratio measured using colour M-mode exceeded 65% (86%, Figure 4) [8].

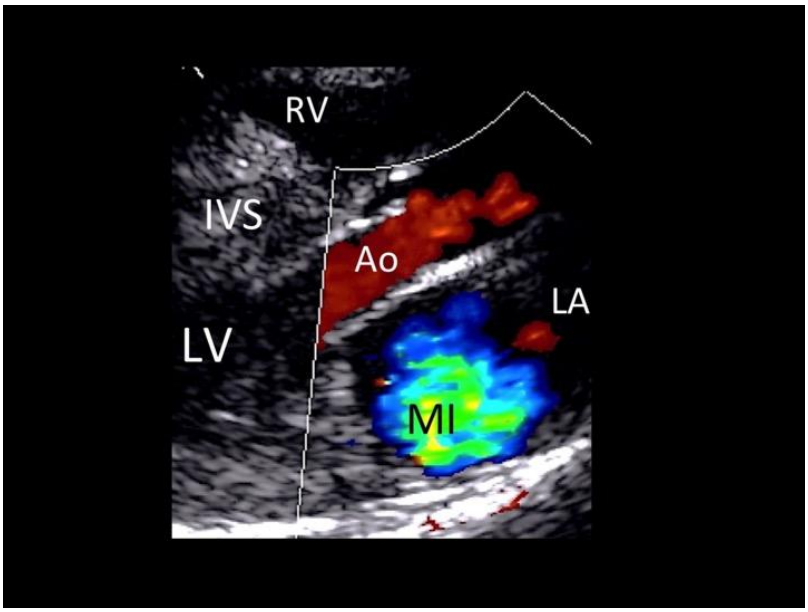

Fig-3: Right parasternal long-axis five-chamber view (colour-flow Doppler mode) recorded during systole, demonstrating the mitral insufficiency.Ao: aorta. IVS: interventricular septum. LA: left atrium. LV: left ventricle. RV: right ventricle. MI: mitral insufficiency. Photos: Alfort Cardiology Unit

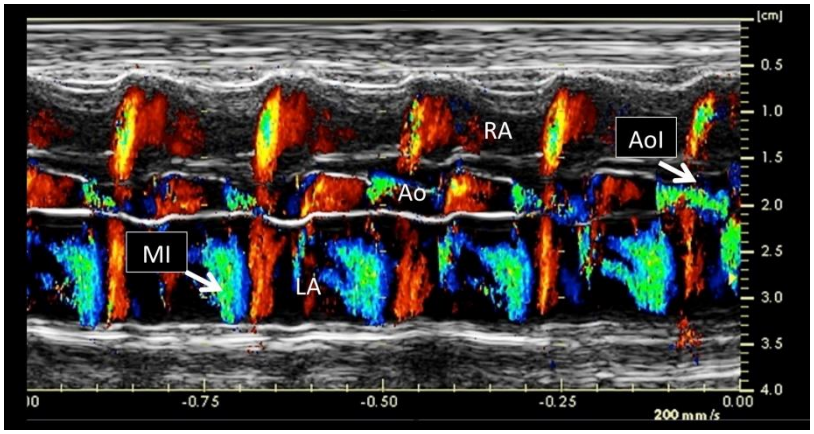

Fig-4: Colour M-mode imaging obtained from a right parasternal long-axis five-chamber view demonstrating both the mitral insufficiency (MI) and the aortic insufficiency (AoI). The aortic regurgitant jet height to aorta width (Ao) ratio is indicative of a severe AoI (86%). LA: left atrium. RA: right atrium. Photo: Alfort Cardiology Unit

The cardiac consequences of this double valvular insufficiency of undetermined origin (related to endocarditis or degenerative valve disease) were left atrial dilation (systolic diameter of 28 mm, [RR = 8.3-15.5 mm] measured using two-dimensional mode, according to the method described by Dudás-Györki *et al.* [9]), and a left ventricular end-diastolic diameter at the upper limit of the usual values (diameter = 14.6 mm, [RR = 9.8-14.7 mm] [9]).

The animal was hospitalized, and received oxygen therapy with a medical treatment combining furosemide[b] (1 mg/kg administered subcutaneously QID) and an angiotensin-converting enzyme inhibitor (ACEi, i.e., imidapril[c] 0.25 mg/kg *per os* SID). Due to its rapid clinical improvement, the ferret was discharged two days later.

CASE REPORT 2

A 13 year-old entire male Dachshund, treated for echocardiographic stage 2 [10] degenerative mitral valve disease (DMVD), with anterior mitral valve leaflet primary chordal rupture and systolic pulmonary arterial hypertension (PAHT; systolic pulmonary arterial pressure = 63 mmHg, [RR < 25 mmHg] [11]), was referred to the cardiology department owing to marked lethargy and progressive abdominal distension over the previous 4 days. A cardiogenic pulmonary oedema had been diagnosed 6 months earlier and the following oral treatment had been administered: benazepril[d] (0.25 mg/kg, BID), furosemide[b] (1 mg/kg, TID), combined with altizide and spironolactone[e] (respective doses of 0.75 mg/kg and 1.81 mg/kg, SID).

On physical examination the dog was lethargic despite its good general state and body condition score (BCS) of 5/9 [12]. The rectal temperature was normal (38.5°C), the mucous membranes were pink and moist, and the capillary refill time was two seconds. Palpation confirmed a distended but not painful abdomen, associated with a positive fluid wave test consistent with ascites. Cardiac auscultation revealed regular tachycardia (heart rate = 160 beats per minutes (bpm)) associated with a left and right apical systolic heart murmur grade IV/VI. The rest of the physical examination was unremarkable.

Due to the medical history and clinical findings, the first hypothesis was ascites secondary to right-sided CHF (although another cause of the abdominal effusion, independent of the existing heart disease, could not be ruled out).

First-line abdominal echography confirmed an enlargement of the liver and the presence of ascites (Figure 5), associated with considerable dilation of the caudal vena cava. Analysis of an abdominal liquid sample obtained under echographic guidance indicated a modified transudate (serohemorrhagic fluid with specific gravity of 1.016, containing 25 g/L of proteins) suggestive of post-hepatic portal hypertension.

As in the earlier examination, echocardiography confirmed the signs of advanced DMVD: enlarged left atrium (left atrium /aorta ratio at end-diastole = 1.5, [RR = 0.52-1.13] [13]) due to severe holosystolic mitral regurgitation, with a maximal area of the regurgitant jet area signal to left atrium area of 100% (assessed using the colour Doppler mapping technique). This regurgitation resulted both from marked thickening of the mitral leaflets and the previously described chordal rupture. According to the PISA (*proximal isovelocity surface area*) method, this regurgitation could be classified as severe but stable (regurgitation fraction of 69% *versus* 66%) [14]. In addition, and for the first time, two-dimensional and M-mode echocardiography demonstrated dilation of the right atrium and right ventricle, resulting from an extensive high velocity tricuspid regurgitation (Vmax= 5.01 m/s using continuous-wave Doppler mode, corresponding to a right ventricle-right atrium pressure gradient of 100 mmHg *versus* 58 mmHg). This

regurgitation resulted from the known PAHT and also from a spherical lesion attached to the septal tricuspid leaflet, highly evocative of valvular endocarditis vegetation (Figures 6A and 7A).

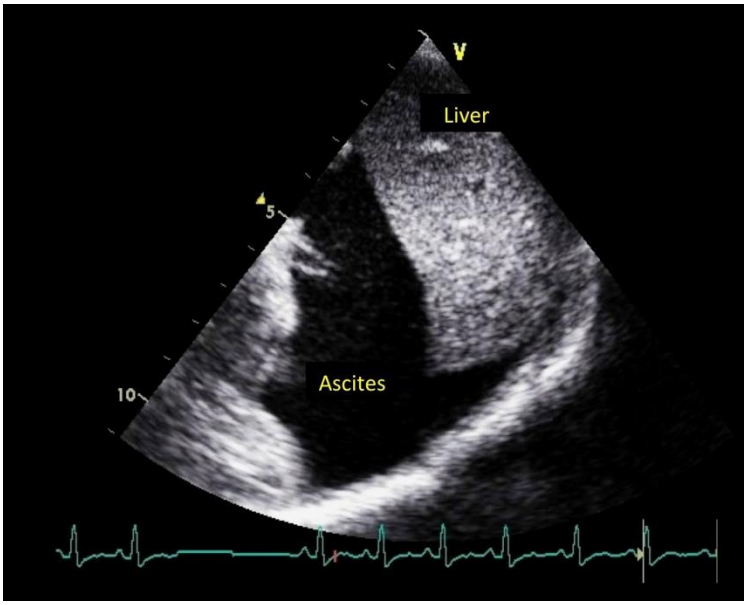

Fig-5: Ultrasound imaging displaying a large amount of abdominal fluid. Photo: Alfort Cardiology Unit

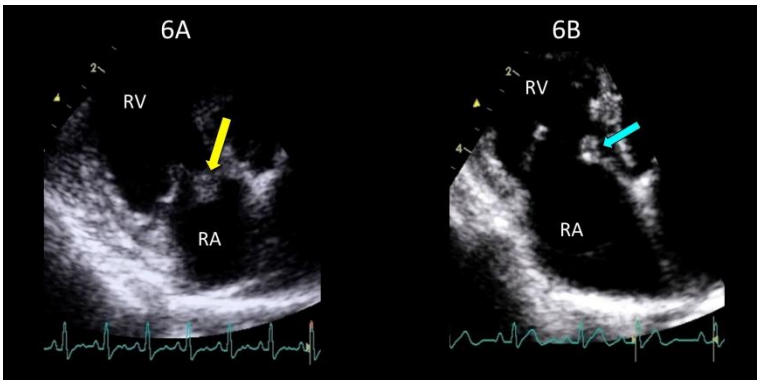

Fig-6 (6A & 6B): Left apical long-axis view (close-up view of the right side), two-dimensionalmode, before (A) and one month after the antibiotherapy (B). Note that the bell-shaped lesion attached to the septal leaflet of the tricuspid valve is smaller in Figure 6B (27 mm^2, blue arrow) than in Figure 6A (36 mm^2, yellow arrow). RA: right atrium. RV: right ventricle. Photos: Alfort Cardiology Unit

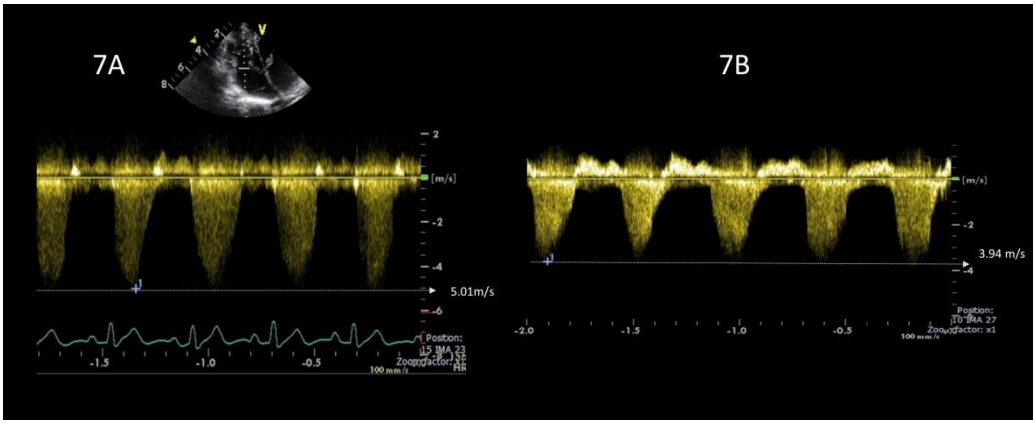

Fig-7 (7A & 7B): Continuous-wave Doppler recording of the tricuspid regurgitant flow from a left apical long axis view (close-up view of the right side), before (A) and after antiobiotherapy (B). Note that the peak velocity of the regurgitant jet is lower in Figure 7B (3.94 m/s) than in Figure 7A (5.01 m/s). Photos: Alfort Cardiology Unit

Based on echocardiography, a tricuspid valve endocarditis was suspected and a complete blood count was performed. Despite the absence of hyperthermia, this confirmed the presence of a neutrophilic leucocytosis (26000 leukocytes/mm^3 [RR = 6000-17000] including 81% neutrophils [RR = 5-80]). Additional tests (blood culture, full urine analysis with urine culture, thoracic radiographs) were proposed to the owner for further investigation but were declined for financial reasons.

Pimobendan[f] (0.1 mg/kg *per os*, BID) was added to the current medical treatment (benazepril, furosemide, and altizide/spironolactone) and combined with oral antibiotics(IV had been refused by the owner) for a minimum period of 8 weeks: clindamycin[g] (11 mg/kg, SID) and marbofloxacin[h] (2 mg/kg, SID). Due to the difficulties encountered by the owner in administering these six drugs by oral route (eight doses in total), Nutri-Plus Gel®[a] was proposed to make treatment compliance easier.

One month later, the dog's general condition was much improved. The echocardiography follow-up revealed a clear regression of the tricuspid valve vegetation and a significant decrease in the tricuspid regurgitation velocity (3.94 m/s *versus* 5.01 m/s indicative of a considerable reduction in the right ventricle-right atrium pressure gradient: 62 mmHg *versus* 100 mmHg, Figures 6B and 7B). The ascites had disappeared. As the animal was in good general condition and the complete blood count did not show any abnormalities, the antibiotic treatment was stopped after 8 weeks and the cardiac treatment was continued.

At the time of writing, (one year later), no worsening of the clinical state has been observed and the treatment has not been modified.

CASE REPORT 3

A 16 year-old Domestic Shorthair female cat weighing 3.9 kg was referred for cardiological examination after 5 days of anorexia. One year earlier, the referring general practitioner had diagnosed hyperthyroidism (total serum thyroxine: 83 nmol/L, [RR = 10-50 nmol/L[i]]) and an oral treatment with methimazole[j] (2.5 mg/day in a single morning dose) and benazepril[d] (0.16 mg/kg/day in a single evening dose) had been initiated. One month after beginning the treatment, the blood chemistry tests revealed chronic kidney disease stage 2, according to the IRIS[k] classification (International Renal Interest Society; last values: plasma urea = 1.03 g/L, [RR = 0.4-0.8 g/L[i]] and plasma creatinine = 23 mg/L, [RR = 8-18 mg/L[i]]), which is a frequently described complication during treatment of feline hyperthyroidism [15].

On physical examination, the cat was skinny (estimated BCS 3/9) [16]. The mucous membranes were pink and the capillary refill time was 2 seconds. Palpation revealed an increased apex beat and femoral arterial pulse intensity, with bilateral and symmetrical thyroid nodules. Cardiac auscultation evidenced a left apical grade IV/VI systolic heart murmur and tachycardia (heart rate non-calculable > 200 bpm). The rest of the physical examination was unremarkable.

Anorexia and weight loss in an elderly cat being treated for hyperthyroidism, complicated by IRIS stage 2 chronic kidney disease might be suggestive of an acute kidney failure. Although dysorexia is rarely described with hyperthyroidism (only 7 to 28% of cases) [17-19] its association with weight loss, tachycardia, as well as increased apex beat and femoral arterial pulse intensity, could also be consistent with persistent hyperthyroidism, due either to an "under-dosing" of methimazole or to poor treatment compliance (however very unlikely, according to the owner).

The apical grade IV/VI systolic heart murmur was indicative of mitral regurgitation, either of functional (related to left ventricular (LV) myocardial remodelling secondary to hyperthyroidism, with or without systemic arterial hypertension) or organic origin (DMVD, related to the animal's age), the two possibly being associated. Echocardiography and measurement of the systemic arterial pressure were therefore indicated.

To reduce the risk of a potential "white coat" effect, measurement of systemic arterial pressure using the Doppler method was first performed and confirmed systemic arterial hypertension (systolic arterial pressure = 240 mmHg[RR <160 mmHg] [20]).

Next, two-dimensional echocardiography evidenced hypertrophy of the left ventricular papillary muscles, associated with a heterogeneous left ventricular myocardium (with hyperechogenic areas in the septal and LV free wall sub-endocardium) and sub-aortic septal hypertrophy (end-diastolic thickness of 8.0 mm, [RR = 2.3-5.7 mm] [21], Figure 8). The later contributed to a systolic anterior motion of the mitral valve, [22] with secondary dynamic LV outflow tract obstruction (systolic peak aortic velocity of 5 m/s [RR = 0.8-1.9 mm] [21], with a "dagger shaped" profile). The mitral valve regurgitation (resulting from both the systolic anterior motion of the mitral valve and slight degenerative remodelling of the mitral leaflets) was confirmed by colour-flow Doppler mode, thus explaining the systolic heart murmur detected on cardiac auscultation. Finally, the transaortic short axis view confirmed a moderate left atrial dilation resulting from this valve failure and the diastolic dysfunction associated with LV myocardial remodelling (left atrium/aorta ratio = 1.47 at end-diastole, [RR = 0.5-1.2] [21], Figure 9). Electrocardiography also demonstrated

the presence of a normal sinus rhythm with a mean heart rate of 210 bpm.

The hypothesis of persistent hyperthyroidism was thus highly probable, due to association of systemic arterial hypertension with the above-mentioned LV myocardial lesions. The diagnosis was confirmed by measuring plasma total T4 concentration (77 nmol/L, [RR = 10-50 nmol/L[i]]). A biochemistry profile was then performed to monitor renal function. Renal parameters were relatively stable by comparison with the previous test results (urea = 1.20 g/L *versus* 1.03 g/L, [RR = 0.4-0.8 g/L[i]], creatinine = 25 mg/L *versus* 23 mg/L, [RR = 8-18 mg/L[i]]).

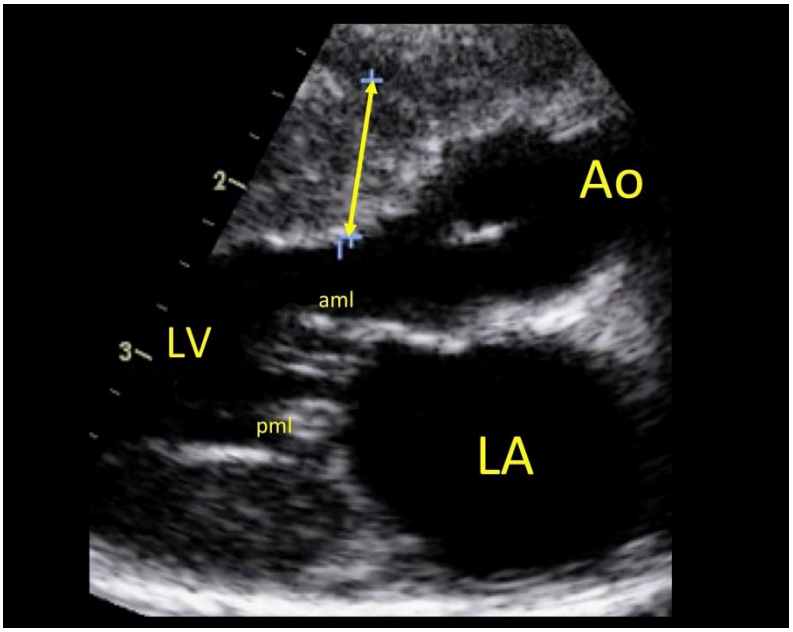

Fig-8: Right parasternal long axis five-chamber view (two-dimensional mode), demonstrating a subaortic septal hypertrophy (double yellow arrow) and mitral leaflets remodelling (aml & pml). aml & pml: anterior and posterior mitral leaflet, respectively. Ao: aorta. LA: left atrium. LV: left ventricle. Photo: Alfort Cardiology Unit

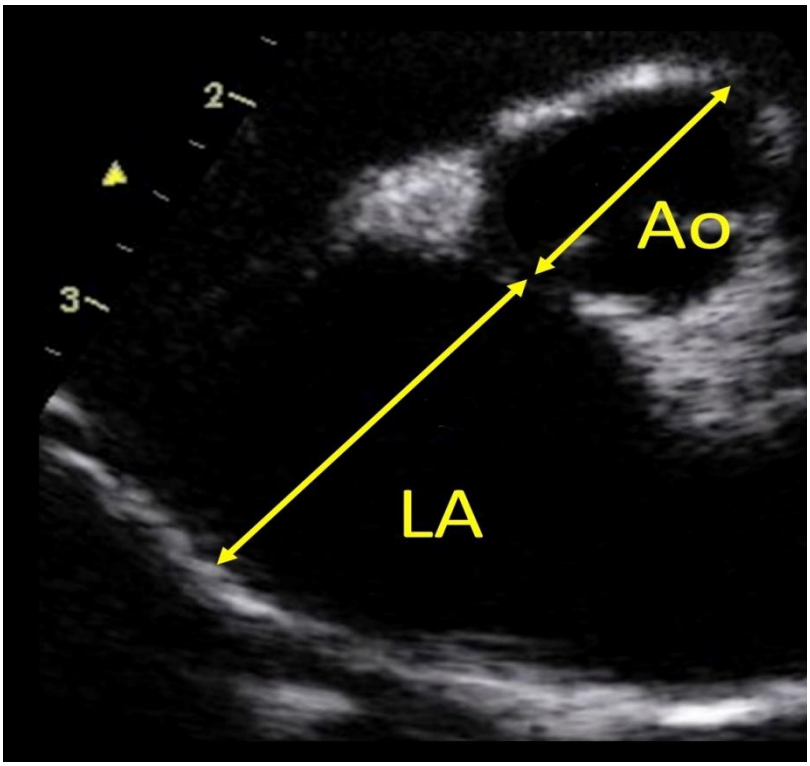

Fig-9: Right parasternal transaortic short-axis view (two-dimensionalmode) confirming a left atrial enlargement.Ao: aorta. LA: left atrium. Photo: Alfort Cardiology Unit

In conclusion, the final diagnosis was persistent hyperthyroidism (despite the ongoing treatment with methimazole), complicated by systemic arterial hypertension and secondary hypertrophic cardiomyopathy, associated with IRIS stage 2 chronic kidney disease.

The oral dose of methimazole[j] was therefore doubled (2.5 mg, BID *versus* 2.5 mg, SID in the morning). Due to the anorexia, Nutri-Plus Gel®[a] was also prescribed « on demand » in order to stimulate the cat's appetite (mainly during the first two weeks, while the modified treatment took effect), and above all to facilitate treatment administration (two drugs in all, requiring three oral doses).

One month later, the owner reported a marked clinical improvement, with increased appetite and mild gain in weight (250 g). The plasma thyroxin concentration was within the RR (35 nmol/L, [RR = 10-50 nmol/L[i]]) with stable renal parameters (urea = 1.10 g/L *versus* 1.20 g/L, [RR = 0.4-0.8 g/L[i]], creatinine = 26 mg/L *versus* 25 mg/L, [RR = 8-18 mg/L[i]]). The systemic systolic arterial pressure had also returned to normal (155 mmHg *versus* 240 mmHg). Echocardiography revealed a marked reduction of the sub-aortic septal hypertrophy (5.8 mm *versus* 8.0 mm) and of the dynamic left ventricular outflow tract obstruction (maximum transaortic flow velocity of 2.4 m/s *versus* 5.0 m/s), with normalization of the left atrium size.

Two years later, at the time of writing, the cat has no longer any clinical signs of hyperthyroidism, with stable renal parameters (urea = 0.9 g/L; creatinine = 24 mg/L). The animal is in good general condition and still receives Nutri-Plus Gel®[a] « on demand » (as the cat may occasionally have a fussy appetite, according to the owner), and the medical treatment remains unchanged.

CASE REPORT 4

A 13-year old 5.2 kg female Cavalier King Charles (Figure 10), treated during 5 years for DMVD (primary chordal rupture regarding the anterior mitral valve leaflet, and secondary acute CHF 18 months earlier) was presented for fatigability, hyporexia and moderate diarrhoea (soft faeces without melena or hematochezia) worsening progressively for the past 5 days.

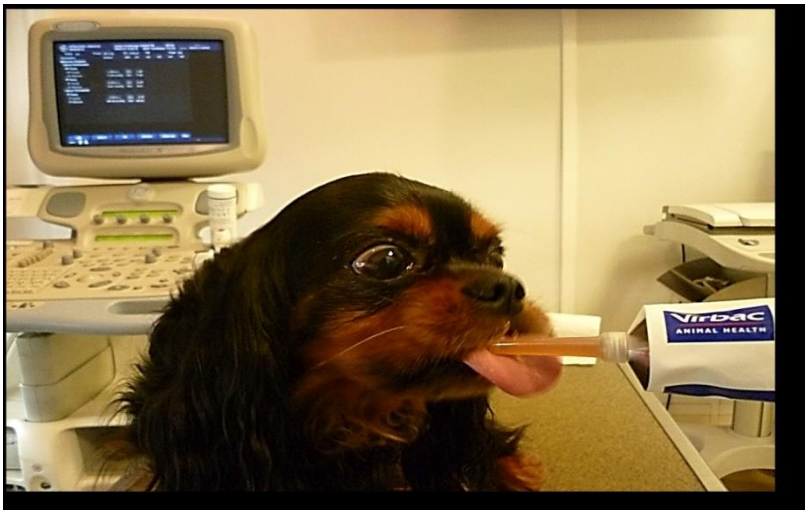

Fig-10: The good palatability of Nutri-plus Gel®[a] allows its spontaneous intake during the consultation with the owner. Photo: Alfort Cardiology Unit

At the last visit, one year earlier, the heart condition was no longer associated with signs of CHF (stage C1 according to the *American College of Veterinary Medicine* (ACVIM) classification [23]), despite severe systolic PAHT (systolic pulmonary arterial pressure = 93 mmHg, [RR < 25 mmHg] [11]) and global cardiomegaly (echocardiographic stage 5 10]).

The current oral treatment consisted of diuretics (altizide[e] 0.72 mg/kg, SID and furosemide[b] 1.44 mg/kg, BID), an ACEi (benazepril[d] 0.48 mg/kg, SID), an inodilator (pimobendan[f] 0.12 mg/kg, BID), and a competitive aldosterone receptor antagonist combined with altizide[e] (spironolactone 1.2 mg/kg, SID).

The dog was up to date with vaccination and endoparasitic treatment, and no change in eating habits was reported. Blood tests (biochemistry, haematology, and electrolytes) performed by the referring veterinarian the day before the consultation, were unremarkable (thus excluding, amongst other things, a cardio-renal syndrome [24,25]).

On physical examination, the dog was thin (BCS 4/9 [12]) and had lost 600 g in one month. The mucous membranes were pink and the capillary refill

time was two seconds. Cardio-respiratory auscultation evidenced a left apical grade V/VI systolic heart murmur (already recorded for the past 3 years) associated with regular tachycardia (heat rate = 176 bpm) as well as the presence of end-inspiratory crackles in the caudo-dorsal region of the lung fields. The femoral arterial pulse was distinct, symmetrical and synchronous with the heart beats. Abdominal palpation was normal. The rectal examination confirmed the presence of soft faeces. The rest of the physical examination was unremarkable.

The medical and clinical history (weight loss, hyporexia, fatigability, tachycardia and abnormal respiratory auscultation) was suggestive of stage C2 CHF (*versus* C1) of the ACVIM classification [23]. Thoracic radiographs were performed for confirmation (Figures 11A and 11B). They revealed mild interstitial pulmonary oedema in the peri-hilar region associated with global cardiomegaly and severe left atrial dilation. Echocardiography did not show any significant change in the heart disease, as compared to the previous examination, except for a greater increase in systolic pulmonary arterial pressure (139 mmHg *versus* 93 mmHg, [RR < 25 mmHg] [11]). The left atrium measured using the two-dimensional mode was severely dilated, but nevertheless stable as compared to the previous control (Figure 12).

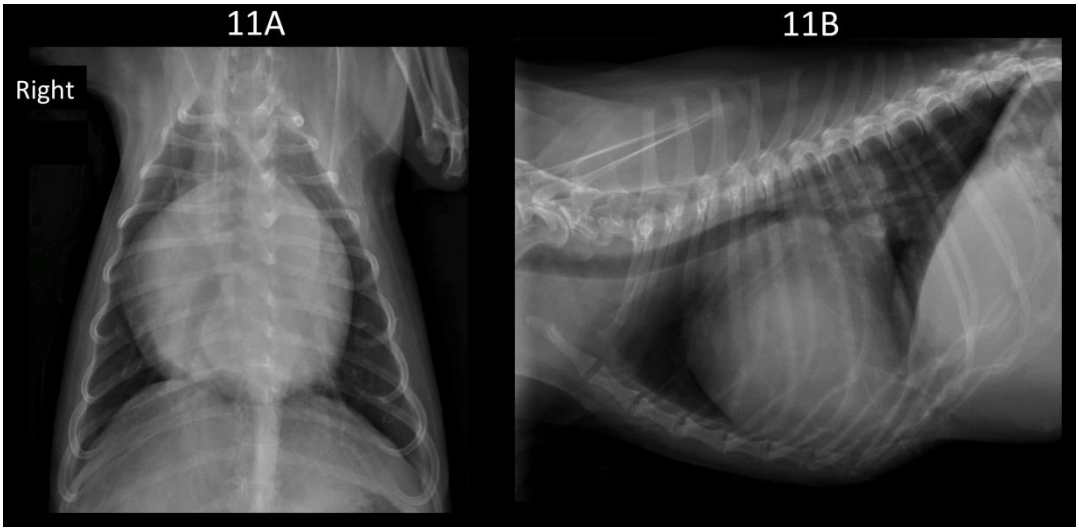

Fig-11: Dorsoventral (A) and right lateral recumbent (B) thoracic radiographs. Photos: Diagnostic Imaging Department of ENVA

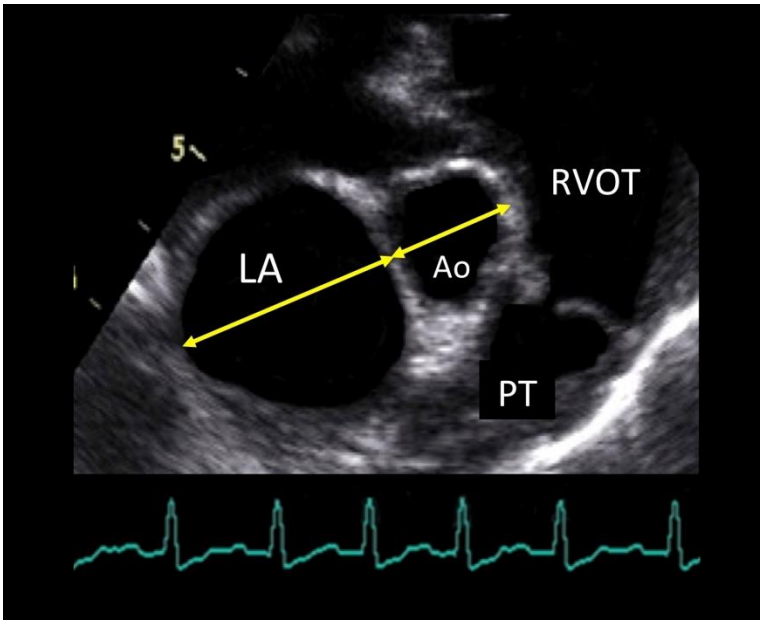

Fig-12: Right parasternal transaortic short-axis view (two-dimensionalmode) confirming a left atrial enlargement. Ao: aorta. LA: left atrium. PT: pulmonary trunk. RVOT: right ventricular outflow tract. Photo: Alfort Cardiology Unit

The current treatment was continued, but the furosemide[b] dosage was increased (1.9 mg/kg, BID). As the owner did not desire any further investigation of the cause of diarrhoea (including abdominal ultrasound examination), a symptomatic oral treatment of metronidazole[l] (15 mg/kg, BID) and diosmectite[m] (150 mg/kg, TID) was first prescribed for 10 days. Nutri-Plus Gel®[a] (Figure 10) was also prescribed to stimulate appetite, limit the already considerable loss in body weight (10% of the initial weight in one month), and facilitate treatment compliance (six drugs in all, requiring eleven oral doses).

During the follow-up visit one week later, the owner reported that the digestive and cardiac symptoms had disappeared (stage C1 of the ACVIM classification [23]). One month later, a gain in weight was noted (200 g). Two years after this episode, the dog was in good general condition and no change in the medical treatment was proposed, as the symptoms had not returned. As the animal's weight is now stable, Nutri-Plus Gel®[a] is recommended solely « on demand », during phases of hyporexia (infrequent to date, according to the owner).

CASE REPORT 5

A 6-month old, entire male Dogo Argentino was referred by the attending veterinarian for echocardiography due to the detection of a heart murmur during a vaccination visit, with no associated clinical signs. The animal was in good general condition on physical examination, but a left basal grade IV/VI systolic heart murmur was confirmed. The rest of the physical examination was unremarkable.

The presence of a high grade left basal systolic heart murmur in a young dog is primarily suggestive of congenital arterial stenosis (pulmonary or aortic). Echocardiography was performed to confirm this hypothesis. The transaortic short-axis view revealed the presence of pulmonary stenosis (Figure 13A). The two-dimensionalmode and the colour-flow Doppler mode confirmed that the stenotic obstruction was exclusively valvular: the pulmonary leaflets were poorly mobile, thickened, with signs of commissural fusion (Figure 14). A significant post-stenotic dilation of the pulmonary artery was also noted. Turbulent blood flow through the stenosis was limited to only 4 mm, while the pulmonary annular diameter was 18.6 mm. Stenosis severity was confirmed using continuous-wave Doppler mode, with a pulmonary flow peak systolic velocity of 5,84 m/s (Figure 13A), corresponding to a pressure gradient of 136 mmHg (pulmonic stenosis are considered as severe when pressure gradients are >100 mmHg) [26]. The two-dimensional right parasternal short-axis view showed a marked right ventricular hypertrophy (1.5 times greater than that of the left ventricle), without any ventricular or right atrial dilatation.

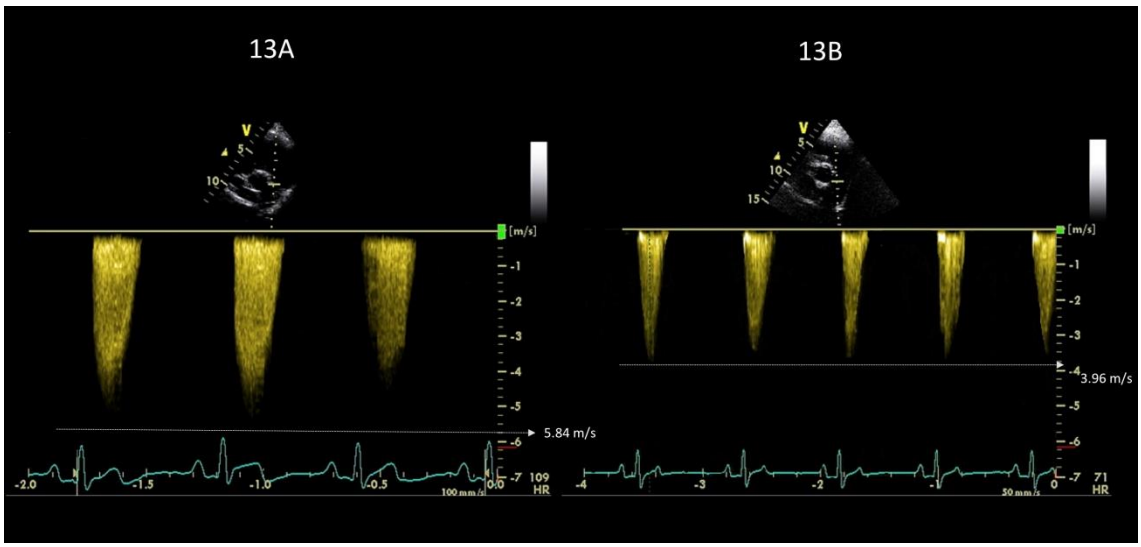

Fig-13: Pulmonary flow recorded using continuous-wave Doppler mode from the right parasternal transaortic short-axis view, before (A) and after valvuloplasty (B) showing a lower peak systolic velocity after surgery (3.96 m/s versus 5.84 m/s at initial diagnosis). Photo: Alfort Cardiology Unit

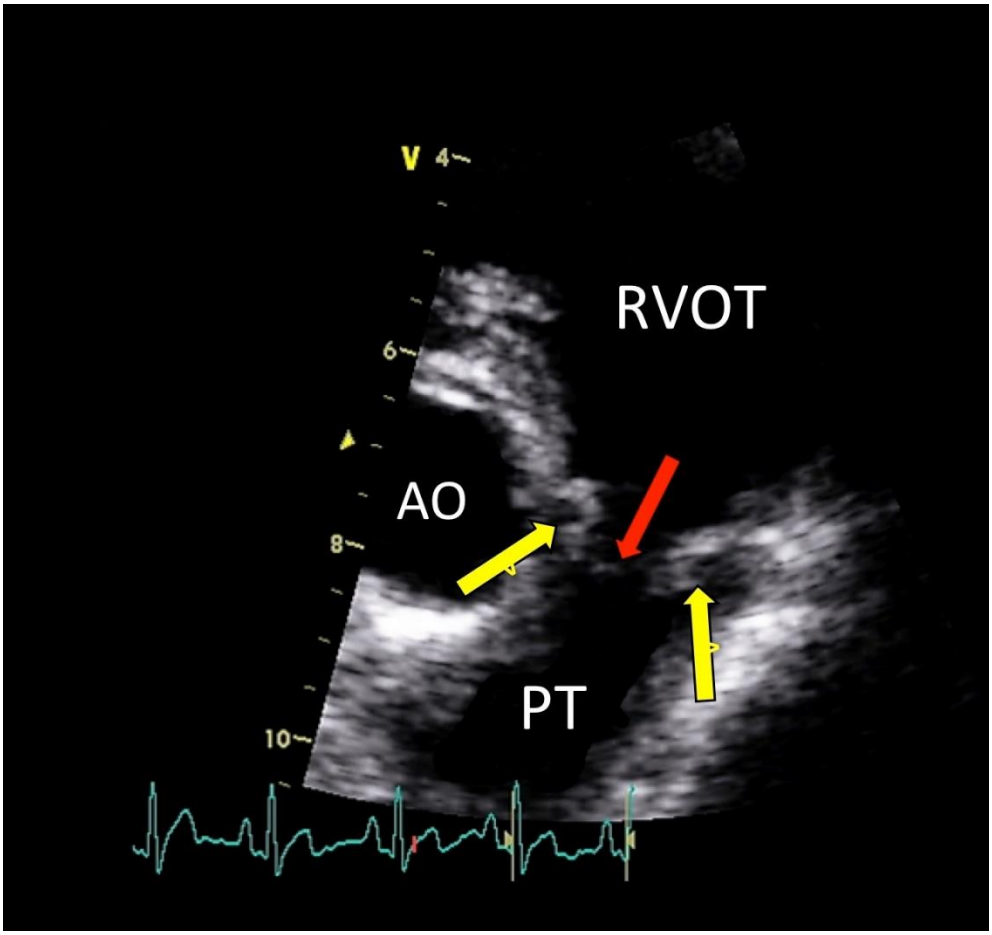

Fig-14: Right parasternal transaortic short-axis view (two-dimensionalmode), recorded during systole.Note that the pulmonary valve leaflets are thickened (yellow arrows) with a commissural fusion (red arrow). Ao: aorta. PT: pulmonary trunk. RVOT: right ventricular outflow tract. Photo: Alfort Cardiology Unit

The concomitant electrocardiogram (ECG) revealed a right axial deviation, resulting from the right ventricular hypertrophy, without any associated arrhythmia.

Due to the pulmonic stenosis severity (high pressure gradient with marked hypertrophy of the right ventricle free wall), a medical treatment was first initiated, i.e., atenolol[n] at a low dosage (0.40 mg/kg *per os*, SID initially) for its negative inotropic and chronotropic action, with the intent to decrease the pressure gradient through the stenosis, reduce the oxygen requirements of the myocardium, increase the ventricular filling time (and therefore coronary perfusion), and thus limit myocardial ischemia [27]. Atenolol has also an anti-arrhythmic effect, which is of particular interest due to the high risk of ventricular arrhythmia caused by right heart remodelling and myocardial ischemia in the case of severe arterial stenosis [28].

Three months after treatment initiation, the clinical and echocardiography follow-up revealed worsening of the right ventricular hypertrophy (increased by 50%), with increased pressure gradient through the stenosis (168 mmHg *versus* 136 mmHg). A balloon valvuloplasty, which is the treatment of choice for severe valvular pulmonic stenosis, was therefore proposed [29, 30]. This percutaneous procedure consists in widening the stenotic lesion by using a balloon catheter. The balloon situated at the end of the catheter is guided through the stenotic valve, and inflated under fluoroscopic guidance and transoesophageal echocardiography to dilate the obstruction, and thereby increase the blood flow through the stenotic orifice (Figure 15) [29, 30].

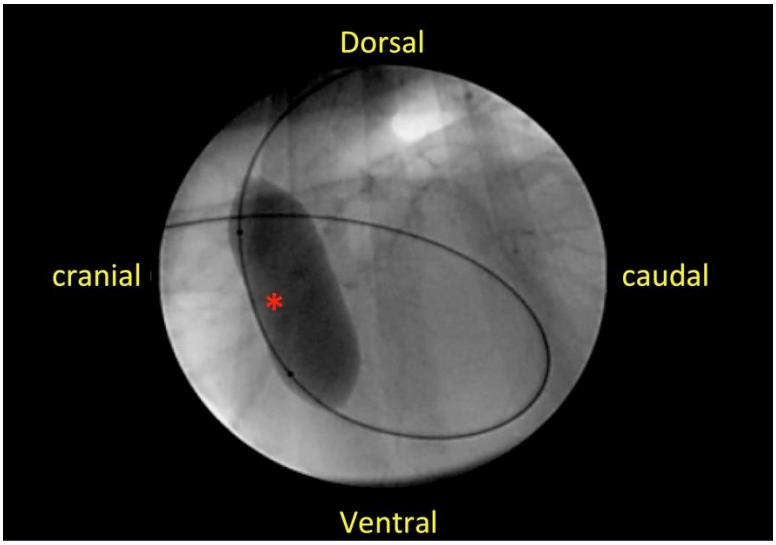

Fig-15: Balloon dilation of the pulmonary stenosis under fluoroscopic guidance: note the balloon's shape* well-fitting the contour of the pulmonary artery. Photo: IMMR, Paris

After balloon valvuloplasty, the animal was hospitalized in the intensive care unit, with ECG monitoring owing to the risk of ventricular arrhythmia. To reduce the stay in hospital (and thereby, limit the stress associated with hospitalization and post-operative pain), multimodal analgesic medication was administered by systemic route, consisting of methadone[o] (0.1 mg/kg administered intravenously, every 4 hours) and meloxicam[p] (0.1 mg/kg administered subcutaneously, SID). In addition, early post-operative enhanced nutrition with a high-energy diet was begun. Nutri-Plus Gel®[a] was used to increase the palatability of the ration.

A recheck echocardiogram was performed 24 hours after the procedure. A marked decrease in the pressure gradient through the stenosis (63 mmHg *versus* 168 mmHg) was observed (Figure 13B), with a pulmonary blood flow width of 10 mm *versus* 4 mm at diagnosis. As the animal was in good general condition, it was discharged with the following medical treatment: meloxicam[p] (0.1 mg/kg *per os*, SID), cefalexine[q] (15 mg/kg *per os*, BID) and atenolol[n] (0.22 mg/kg *per os*, TID). Finally, the owner was instructed to restrict the dog's physical activities until the next echo-Doppler recheck, one month after the surgery. At this recheck, the trans-stenotic gradient was 58 mmHg, and the animal was in very good general condition. At the time of writing, one year after balloon valvuloplasty, the dog is still in perfect health and the owner does not report any clinical signs.

DISCUSSION

This collection of cases illustrates 5 routine clinical situations encountered in veterinary cardiology in which the use of a palatable high-energy complementary feed is of practical value:

(i) Facilitating restraint of an animal during echocardiography (case 1);
(ii) Facilitating treatment compliance in advanced heart diseases requiring multi-drug treatments (cases 2, 3 and 4);
(iii) Maintaining body weight during periods of anorexia in cats with myocardial disease and renal failure (case 3) as well as in dogs with advanced heart disease, such as DMVD (case 4);
(iv) Post-operative recovery (case 5).

Restraint of an animal is essential during echocardiography to enable the operator to obtain high quality images and measurements of quantitative variables that are both repeatable and reproducible. Echocardiography has been used routinely in dogs and cats for more than three decades. The recent increased ownership of exotic animals has led today's veterinarians to offer the same level of care as that proposed for dogs and cats. However, obtaining images in such animals can be difficult, partly because of their small size. These examinations may therefore require sedation or even anaesthesia, both of which can distort certain measurements (flow velocity, inotropism, chamber wall thickness, even chamber diameter), as shown in different species [31-33]. As illustrated in case 1, the administration of Nutri-Plus Gel®[a] in the ferret throughout the echocardiography provided an excellent way of distracting the animal and enabled a complete examination to be performed without sedation.

As regards the nutritional aspect, it is useful to remember that in animals with heart diseases, surveillance of their nutritional condition and appropriate adaptation of the ration can help both to maintain the lean body mass and the quality of life. As in humans, animal heart diseases are very diverse and may be congenital or acquired, primary or secondary. However, their metabolic consequences are « univocal », progressing with disease severity. The

more the disease progresses, the greater the metabolic consequences, leading to aggravation of the clinical signs associated and also to cachexia, a wasting syndrome defined as a loss of muscle mass with or without loss of body fat [34].

Although obesity is a risk factor in the development of heart disease in humans [35] recent studies have shown that once heart failure is present, the excess weight can undoubtedly have a protective effect [36, 37]. This is known as the « obesity paradox » [38]. In addition, it has also been shown that the presence of cachexia in small animals with heart failurerepresents a negative prognostic factor, both regarding quality of life and lifetime [39, 40]. As example, dogs with CHF (dilated cardiomyopathy or DMVD) that have gained weight, live longer than those with stable or decreased body weight [40]. Similarly, cats suffering from decompensated heart diseases (restrictive, hypertrophic, dilated, non-classified or right arrhythmogenic cardiomyopathies) with the lowest (and also the highest) body weights have reduced survival times compared with those with body weights in the intermediate ranges [39]. It is therefore easy to understand that hyporexia or anorexia (as described in cases 3 and 4), leading to a loss of body weight, is a warning sign that needs to be taken into account as early as possible in an animal with heart disease. In the study by Freeman *et al* [4], 34% of dogs with dilated cardiomyopathy or DMVD, and 84% of dogs euthanized as a result of CHF, showed anorexia, thus illustrating the frequency of this clinical sign in canine heart diseases. Moreover, anorexia also alters the animal's quality of life of the animal, which can partly influence the owner's decision to continue or, conversely stop treating a pet with heart disease. Studies have shown that quality of life is highly important to owners of dogs and cats with heart disease, with most owners willing to trade survival time for quality of life for their heart disease-affected animals [41, 42].

Apart from the nutritional aspects of an animal with heart disease, compliance with a medical treatment protocol is also very important to ensure its successful outcome. This can be a real challenge for both the veterinarian and the owner. Administering medication is not always easy (dysorexic animal, tablet size, galenic features, unpalatability, number of drugs and number of doses *etc.*) which can result in the owner becoming less motivated to continue the veterinarian's prescribed treatment « to the letter». This is all the more true when the disease is chronic, such as DMVD, requiring months or even years of continuous multiple treatments. The median survival of dogs with DMVD ISACHC classes 2 and 3 (i.e., moderate and severe CHF respectively, as in cases 2 and 4) according to the ISACHC (*International Small Animal Cardial Health Council*) classification, has been shown to be 28 and 9 months respectively [43]. The quality of the explanations given to the owners by the practitioner concerning their pet's disease, the justification for each treatment and the ease of treatment administration has a positive effect on compliance [44]. The use of a suitably-adapted, highly-palatable complementary feed, such as Nutri-Plus Gel®[a], can also help facilitate treatment compliance, especially during chronic heart disease, for which the number of drugs and their frequency of administration can be high, as illustrated in cases 2, 3 and 4.

Finally, the nutritional approach is a key point in management programs for post-surgery recovery in human patients (*Enhanced Recovery Programs* (ERPs) [45]). These programs consist of multimodal surveillance of the patient throughout the peri-operative period, the aim being to achieve as rapid a return as possible to a similar physical condition to the one before surgery. This approach can be divided into three phases: i) pre-operative (patient evaluation, suitable pre-operative nutrition); ii) peri-operative (mildly invasive surgery, standardized anaesthesia protocol); iii) post-operative (multimodal management of pain, early post-operative nutrition and early mobilization). One corollary of this approach is a shorter hospitalization period, which also reduces post-operative complications [45]. It has been demonstrated in human medicine that malnutrition, notably during vascular surgery procedures, can increase the likelihood of post-operative complications [46]. In addition, surgical trauma and anaesthesia result in metabolic stress and subsequent hormonal alterations (insulin, cortisol, catecholamines), responsible for increased catabolism and decreased anabolism [45]. Post-operative re-nutrition combined with effective analgesia and early mobilization helps to ensure the rapid resumption of intestinal motility and absorption and, in consequence, limits muscle loss, secondary infections and improves wound-healing [47]. Case 5 represents an illustration of this type of approach in a dog with severe heart disease that had undergone an endovascular procedure (valvuloplasty).

CONCLUSION

In conclusion, the use of a palatable complementary feed, such as Nutri-Plus Gel®[a], in veterinary cardiology constitutes a valuable option in different clinical situations, including facilitation of restraint during an examination (e.g., echocardiography), promoting treatment compliance (notably during long-term multitherapy), and providing nutritional support during periods of dysorexia associated with advanced heart diseases and post-operative rehabilitation. Nevertheless, for these last three indications, it must always be used as a complement to the proposed medical treatment and appropriate diet, rather than a replacement of the later.

FOOT NOTES

[a] NUTRIPLUS-GEL®, VIRBAC, 06511 Carros, France.
[b] FUROZENOL®, VETOQUINOL, 70200 Lure, France.
[c] PRILIUM®, VETOQUINOL, 70200 Lure, France.
[d] FORTEKOR®, NOVARTIS, 92500 Rueil-Malmaison, France.
[e] ALDACTAZINE®, PFIZER, 75014 Paris, France.
[f] VETEMEDIN®, BOEHRINGER INGELHEIM, 75013 Paris, France.
[g] ANTIROBE®, ZOETIS, 75014 Paris, France.
[h] MARBOCYL®, VETOQUINOL, 70200 Lure, France.
[i] Laboratoire Idexx Alfort, 94140 Alfortville, France.
[j] METHIMAZOLE®, DECHRA VETERINARY PRODUCTS SAS, 92150 Suresnes, France.
[k] http://www.iris-kidney.com
[l] FLAGYL®, SANOFI-AVENTIS, 94400 Vitry-Sur-Seine, France.
[m] SMECTA®, IPSEN, 92100 Boulogne-Billancourt, France.
[n] TENORMINE®, ASTRAZENEKA, 92844 Rueil-Malmaison, France.
[o] CONFORTAN®, EUROVET ANIMAL HEALTH, 5531 Ae Bladel, Pays-Bas.
[p] METACAM®, BOEHRINGER INGELHEIM, 51100 Reims, France.
[q] RILEXINE®, VIRBAC, 06516 Carros, France.

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