Successful Treatment of a Congenital Pulmonic Valvular Stenosis in a Snow Leopard (*Uncia uncia*) by Percutaneous Balloon Valvuloplasty

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SUCCESSFUL TREATMENT OF A CONGENITAL PULMONIC VALVULAR STENOSIS IN A SNOW LEOPARD (*UNCIA UNCIA*) BY PERCUTANEOUS BALLOON VALVULOPLASTY

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Abstract: A 3-yr-old intact female snow leopard (*Uncia uncia*) was evaluated for progressive apathy, lethargy, and decreased appetite. Cardiac auscultation revealed a left basal grade IV/VI systolic ejection murmur, and an echocardiogram confirmed a severe pulmonic valvular stenosis (pressure gradient of 98 mm Hg). The lesion was managed by balloon valvuloplasty, resulting in a marked pressure gradient reduction (30 mm Hg). The cat recovered well, and clinical signs resolved. This is the first description of a pulmonary valve stenosis and management with balloon valvuloplasty in a wild felid.

Key words: *Uncia uncia*, cardiac disease, congenital pulmonic stenosis, balloon valvuloplasty, cardiac imaging.

BRIEF COMMUNICATION

Congenital pulmonic stenosis (PS) rarely occurs in cats.[7,10] However, it is considered one of the most common congenital cardiac defects in dogs,[6,9,10] and it is a well-described condition in humans.[1]

A 3-yr-old captive-born female snow leopard (*Uncia uncia*) presented with moderate, chronic apathy. The animal arrived at the Ménagerie du Jardin des plantes–National Museum of Natural History at the age of 2 yr old. It was vaccinated against feline panleukopenia, feline rhinotracheitis, feline calicivirus, rabies (1 mL i.m.; Quadricat, Merial, 69007 Lyon, France), and feline leukemia virus (1 mL i.m.; Purevax FeLV, Merial) and was regularly dewormed with fenbendazole (50 mg/kg p.o., Panacur 500, Intervet, 49070 Beaucouze, France).

From the time of arrival , despite normal appetite, the snow leopard was very calm and remained in the same location throughout the day, and over a period of 15 mo, apathy progressed, the animal became more lethargic, and appetite decreased.

On 5 May 2009 (day 0), it was immobilized with a combination of medetomidine (2 mg; 71.4 μg/kg i.m.; Zalopine, Orion Pharma Animal Health, FI-20101Turku, Finland) and ketamine (120 mg; 4.3 mg/kg i.m.; Imalgene 1000, Merial) for a first physical examination and blood sampling. The animal was found to be in good general condition (28 kg) with normal mucous membrane color and a capillary refill time of <2 sec. However, cardiac auscultation revealed a grade IV/VI left basilar systolic ejection murmur. Complete blood count and serum biochemistries were within normal ranges. On the basis of the murmur and the lack of other clinical findings, the primary differential diagnosis for the apathy was heart disease; however, further investigation was needed to exclude any other internal pathologic processes.

Two months later, the cat was immobilized with the same anesthetic protocol and was found to be in stable body condition (27 kg). Abdominal radiography, ultrasound, and laparoscopy were normal. The previously noted left basal grade IV/VI systolic heart murmur was unchanged. Thoracic radiography revealed moderate right ventricular enlargement with mild tracheal elevation. The peripheral pulmonary vasculature was considered normal. Electrocardiogram showed a normal sinus rhythm with a heart rate of 100 to 120 bpm.

Further cardiac investigation was scheduled, and 6 mo later, the cat was immobilized with the same anesthetic protocol and brought to the

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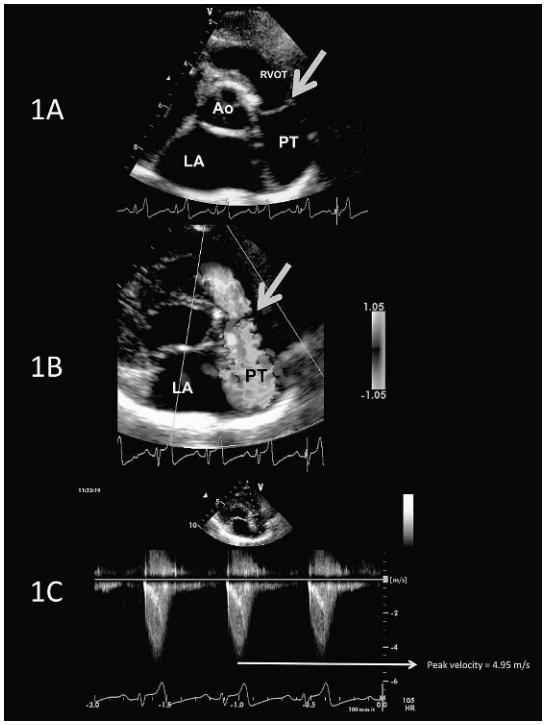

Figure 1. Echocardiographic and Doppler examination at day 0. **A.** Two-dimensional echocardiogram (right parasternal short axis view at the level of the aortic valve during systole) showing the valvular pulmonic stenosis (arrow). **B.** Color-flow Doppler mode (right parasternal short axis view at the level of the aortic valve) confirming a marked narrowing of the pulmonary flow at the level of the pulmonic valve (arrow). **C.** Continuous-wave Doppler mode confirming a high-velocity flow (4.95 m/sec) across the pulmonic valve. Ao, aorta; LA, left atrium; PT, pulmonary trunk; RVOT, right ventricular outflow tract.

National Veterinary School of Alfort for echocardiogram with Doppler evaluation.

Two-dimensional echocardiography showed a valvular PS with doming of the leaflets in systole, suggesting a valvular fusion (Fig. 1A), which was confirmed by color-flow Doppler mode (Fig. 1B). A high-velocity flow (4.95 m/sec) was recorded across the pulmonic valve with the use of continuous-wave Doppler mode (98 mm Hg estimated via modified Bernoulli equation), consistent with a severe pulmonic stenosis (Fig. 1C) and resulting in severe concentric right ventricular hypertrophy (threefold increase from normal) and a marked poststenotic dilation of the main pulmonary artery on the right parasternal transaortic short axis view. The maximal internal diameter of the pulmonary flow was estimated with the color-flow Doppler mode, at only 5 mm (for an annular diameter of 16 mm).

Two-dimensional color tissue Doppler imaging (TDI) revealed marked systolic and diastolic dysfunction of the longitudinal right ventricular myocardial motion.

The snow leopard was scheduled for balloon valvuloplasty. Preoperative complete blood count, serum biochemistries, and a coagulation profile were normal. At day 0 + 7 mo, the cat was anesthetized with the same protocol and transferred to the Institut Mutualiste Montsouris Recherche for pulmonic valve balloon valvuloplasty. The animal was intubated, and anesthesia was maintained with inhaled 0.5% isoflurane (Isoflurane, Abbott, 94528 Rungis, France) carried in oxygen (2 L/min) and a ketamine infusion rate of 100 mg/hr i.v. The method for pulmonary balloon valvuloplasty was similar to that previously published in dogs.[3,5] The right jugular vein was exposed to place a 12-Fr introducer sheath (Cordis, Miami Lakes, Florida 33014, USA). Sodium heparin (150 IU/kg i.v.; Heparine, Sanofi Aventis, 75635 Paris, France) was administered before catheter introduction into the vessels. A 7-Fr pigtail angiographic catheter (Cook Medical Inc., Bloomington, Indiana 47402, USA) was advanced with fluoroscopic guidance (General Electric OEC 9900 elite C-arm, Wauwatosa, Wisconsin 53226, USA) from the right jugular vein into the right ventricle.

A right ventriculogram was performed with the use of intravenous contrast media, meglumine ioxitalamate, and sodium ioxitalamate (30 mL at an injection rate of 20 mL/sec; 1 mL/kg; Telebrix®35, Guerbet, 95943 Roissy CdG, France).

Infundibular hypertrophy, valvular PS, and poststenotic dilatation of the pulmonary artery were observed. Valvuloplasty was then performed with the use of a 16-mm balloon dilatation catheter that was passed across the stenotic pulmonic valve with a 0.035-inch (0.89-mm) guide wire (Boston Scientific, Boston Scientific Place, Natick, Massachusetts 01760, USA). The balloon catheter (Boston Scientific) was inflated twice, until a definite waist was observed, for a maximum of 5 sec per inflation. A postprocedure angiogram showed enlargement of the contrast media flux through the pulmonic valve when compared with a predilatation angiogram. The jugular vein was sutured, and a small skin suture was placed at the vascular access site to avoid bleeding after removal of the introducer. Cefamandole (20 mg/kg i.v.; Cefamandole®, Panpharma, 35 133 Fougères, France) was adminis-

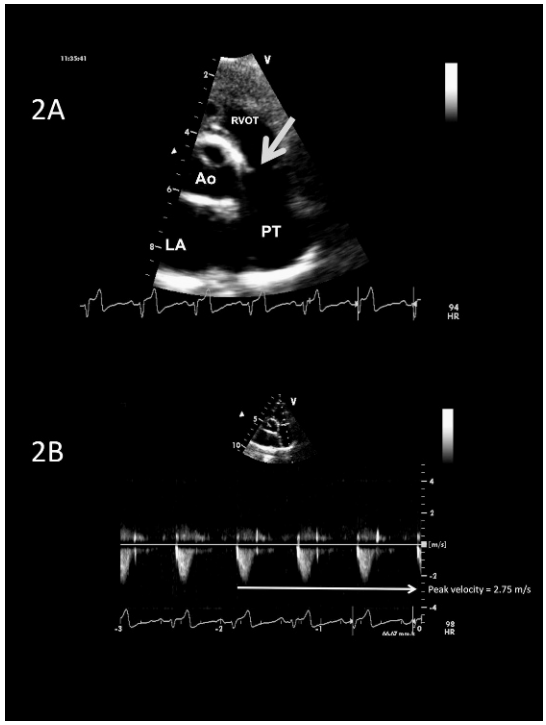

Figure 2. Echocardiographic and Doppler examination 2 mo after surgery. **A.** Two-dimensional echocardiogram (right parasternal short axis view at the level of the aortic valve during systole) showing a widening of the valvular orifice (arrow). **B.** Continuous-wave Doppler mode confirming a marked decrease of the pulmonary systolic flow velocity (2.75 m/sec vs. 4.95 m/sec at day 0). Ao, aorta; LA, left atrium; PT, pulmonary trunk; RVOT, right ventricular outflow tract.

tered for antibiotic prophylaxis, and analgesia was completed with flunixine meglumin (28 mg i.v.; 1 mg/kg; Finadyne®, Schering Plough Vétérinaire, 92307 Levallois-Perret, France).

Postoperatively, the snow leopard showed tachycardia and right ventricular premature complexes treated by infusion of xylocaine (40 mg i.v.; 1.4 mg/kg; Xylocard®, AstraZeneca, 92844 Rueil-Malmaison cedex, France). Recovery was prolonged, with tachycardia and phases of ventricular premature complexes (for >6 hr) treated regularly with xylocaine injections (3 × 40 mg/hr, i.m.). Aspirin (1,000 mg; 35.7 mg/kg p.o. u.i.d. q3d; 15 Aspegic®, Sanofi Aventis) was prescribed to prevent clot formation in association with valvuloplasty.

The following day, the animal appeared calm and resumed eating. Over the following weeks, the animal became more active and appetite increased. Two months after surgery (day 0 + 9 mo), the animal was immobilized with the same anesthetic protocol for postoperative evaluation. It had gained weight (32 kg vs. 28 kg pre-operatively), was alert, and appeared clinically healthy. A mild systolic ejection murmur (grade II/VI vs. IV/VI before valvuloplasty) was present over the left heart base. M-mode echocardiography showed a significantly decreased thickness of the right ventricular myocardial wall (10.9 mm vs. 16.3 mm before balloon dilatation) suggesting a decreased pressure gradient across the pulmonic valve.

The PS improved on 2D mode images (Fig. 2A), and the maximal internal diameter of the pulmonary flow was doubled (10 mm vs. 5 mm before balloon dilation). Maximal continuous-wave Doppler flow velocity across the pulmonic valve was dramatically decreased (2.75 m/sec vs. 4.95 m/sec; Fig. 2B), thus confirming a much lower pressure gradient than before surgery (30 mm Hg vs. 98 mm Hg). Finally, 2D color TDI revealed a marked improvement of the right myocardial systolic function (maximal longitudinal systolic velocity at the right base of 7.5 cm/sec vs. 3.0 cm/sec before valvuloplasty). At the time of writing, 11 months after surgery, the animal is still doing well.

In humans and in dogs, pulmonary balloon valvuloplasty (BV) is the treatment of choice for PS.[7,8] In humans, it has been shown to be effective in both short-term and long-term studies.[8] In dogs, BV has been shown to reduce clinical signs and improve prognosis and quality of life.[7,9] In cats, BV for PS has been reported, but studies were limited to single cases. Only one study has evaluated the effects of BV with pulmonic infundibular stenosis and showed that this procedure might significantly improve prognosis in cats.[10] However, dogs with PS (which is most commonly valvular, without subvalvular fibrosis pulmonary artery hypoplasia or elements of valve dysplasia) are more likely to be treated successfully.[4] Moreover, BV has best results on valvular pulmonic stenosis in which commissural fusion is the major abnormality.[6] To date, commissural fusion is the only lesion that has been shown to respond consistently to balloon dilation in veterinary patients.[6] The decision to treat PS is based on the severity of clinical signs and the magnitude of the pressure gradient across the pulmonic valve.[9] In cats, primary pulmonic infundibular stenosis with a right ventricular outflow tract gradient of >70 mm Hg should be considered severe disease with a very guarded to poor prognosis.[10] In the present case, the animal presented with marked clinical signs and a high-pressure gradient of 98 mm Hg (despite

anesthesia) recorded across the pulmonic valve. The main lesion was a valvular fusion at the leaflet tips. All this fully justified the decision to treat the PS with a BV. Criteria for appropriate balloon diameter in the treatment of valvular pulmonic stenosis are reported in both dogs and humans, with optimal size being 1.2–1.5 times the annular diameter.[4,6] Because this was the first use of BV in a snow leopard, the preference was to use a 16-mm balloon (for an annular diameter estimated at 16 mm) instead of a 20-mm balloon to dissect the valvular fusion because of the uncertainty of potential complications that might have been induced by a larger balloon. A mild PS was still present after valvuloplasty because of a slightly reduced motion of the pulmonary cusps during systole. Long-term follow-up of the animal will dictate whether a solitary treatment is sufficient or if it needs to be repeated. Because PS is known to have a genetic basis in some species, such as canine species,[2] echocardiography should be part of the standard examination of captive snow leopards to help determine the prevalence of this disease in the captive population. This is the first description of a pulmonary valve stenosis in a wild felid managed by balloon valvuloplasty.

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