Hypertrophic cardiomyopathy (HCM) in a Jaguar (*Panthera onca*)


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**Summary**

A 20-month-old female jaguar (*Panthera onca*) developed anorexia, lethargy, loss of appetite and breathing difficulties. Echocardiography and necropsy showed a non dilated, left ventricular asymmetric myocardial hypertrophy, pulmonary oedema and pericardial and pleural effusions. Disarray of cardiac muscle cells and interstitial myocardial fibrosis were identified on histological examination. Polarized microscopy used on picrosirius red-stained sections showed an increase either of total collagen as well as of the type I/type III collagen ratio in the damaged myocardium. Clinical, gross and microscopic lesions were consistent with hypertrophic cardiomyopathy (HCM) which is for the first time described in a wild animal.

**Keywords:** Hypertrophic cardiomyopathy, Jaguar (*Panthera onca*), echocardiography, histology, collagen.

**Résumé**

Cardiomyopathie hypertrophique (CMH) chez un Jaguar (*Panthera onca*)

Une femelle jaguar (*Panthera onca*) de 20 mois, anorexique et léthargique, a présenté une perte de l’appétit et des difficultés respiratoires. L’échocardiographie et l’autopsie ont mis en évidence une hypertrophie asymétrique du myocarde sans dilatation du ventricule gauche, un œdème pulmonaire ainsi que des épanchements péricardiques et pleuraux. À l’examen histologique, les fibres musculaires cardiaques sont apparues désordonnées et une fibrose interstitielle du myocarde a été observée. La coloration au picrosirius couplée à une analyse microscopique en lumière polarisée a révélé une augmentation de la teneur totale de collagène ainsi que du rapport collage type I / collage type III dans le tissu myocardique lésé. Les signes cliniques et les lésions macroscopiques et microscopiques étaient compatibles avec une cardiomyopathie hypertrophique (CMH), décrite, pour la première fois, chez un animal sauvage.

**Mots clés :** Cardiomyopathie hypertrophique, Jaguar (*Panthera onca*), échocardiographie, histologie, collagène.

**Introduction**

The jaguar, also known as “jaguareté” or South-American tiger (*Panthera onca*) is the largest feline in the Americas and it is under extinction risk [5]. In fact, this endangered animal species has been avidly over hunted so that it becomes rare and had to be protected in many countries [15].

Hypertrophic cardiomyopathy (HCM) is a primary myocardial disease characterized by a disproportionately thickened ventricular septum containing numerous disorganized cardiac muscle cells [2, 9]. HMC affects cats and dogs and resembles to a similar disease of human beings [1]. Since the first descriptions, a genetic background of the disease has been suspected in human beings and cat [9, 12]. Even though many mutations have been found in both species the search of a genetic or biochemical marker depicting the presence of HCM has been unsuccessful until now [4, 10]. Stress has recently been postulated as a factor involved in the pathogenesis in human beings [3]. So far as it is known, HMC has been found only in humans, domestic cats and dogs [8, 16]. This report describes a fatal case of HCM in a 20-month-old female jaguar from a zoological garden in La Plata, Argentina.

**Materials and Methods**

**Case Report**

A 20 month old female Jaguar developed anorexia, lethargy, laboured breathing and head tremors. It was sedated at the zoo with Pneudart disposable dart-gun (Pneudart Inc., PA, USA) and Tiletamine (Telazol, Fort Dodge, USA) and the case animal was admitted to the school’s hospital for abdominal and thoracic radiography, and echocardiography evaluation. The sedation was maintained by additional injections of Ketamine (Vetalar, Parke Davis, USA) through an extension line during all imaging studies. Echocardiography examination was performed with a Toshiba CoreVisionPro Ultrasound (Tochigui-Ken, Japan) with a 7.5 MHz transducer while radiographic imaging was performed using a conventional 200 mA and 150 kV-Toshiba X-ray device (Tochigui-Ken, Japan). The jaguar’s heart was scanned in long- and short-axis views using a right parasternal window in left lateral decubitus. Symptomatic treatment was performed to reduce pleural oedema and to re-establish normal breathing. It consisted on enalapril malate, isosorbide dinitrate and furosemide. The health status worsened and the jaguar died 2 weeks later.
MORPHOMETRIC AND HISTOLOGICAL ANALYSES

A complete post-mortem examination was conducted and morphometric measures were taken.

Tissue samples were taken on a transverse section of the ventricular septum and of the left free wall perpendicular to the long axis of the left ventricle, embedded in paraffin, sectioned at 5 μm and stained with haematoxylin-eosin. Collagen evaluation was done in sections stained with the Picrosirius red technique and viewed with polarised light. For this purpose the sections were deparaffinised, hydrated through graded ethanol and stained for 1 hour in a 0.1% solution of Sirius Red (Direct Red 80, Aldrich, Milwaukee, WI 53233, USA) dissolved in aqueous saturated picric acid. The sections were then rapidly washed in running tap water and counterstained with Harris haematoxylin. A conventional optical microscope (BX50 Olympus microscope, Japan) with a strong light source (halogen lamp), coupled to an analyzer (U-ANT Olympus, Japan) and a polarizer (U-POT Olympus, Japan) were used to study the birefringence of the stained collagen.

All the stained sections were observed under a microscope (Olympus BX-50, Tokyo, Japan) and the images were captured using an analogical RGB video camera (Sony DXC-151A CCD, Tokyo, Japan) connected to a high performance computer (PC Pentium III, 450 MHz, 128Mb RAM) through a frame grabber (Flashpoint 128, Integral Technologies, Inc, Indianapolis, IN, USA). The digital images were then processed with image analysis software (Image-Pro Plus for Windows 95/98 v4.1 - Media Cybernetics, Silver Spring, MA, USA). The resolution of the microscopic images was of 640x480 pixels with a spatial calibration yield of 1.27 μm/pixel. Ten images were obtained from each tissue section. To separate the stained tissues from other objects colour segmentation based on the optical density of the object was performed. A one way analysis of variance was performed to determine the collagenous fibres distribution. The Bonferroni t-test was used as a post hoc test [13].

Results

Physical examination registered tachypnea with deep lung sounds. Radiography and echocardiography revealed a non dilated left ventricle with asymmetric hypertrophy (figure 1). The apex and mild ventricular areas were also hypertrophied, the left ventricular outflow tract was obstructed and the mitral valve displaced. Pulmonary congestion and oedema were evident in radiographic imaging while pericardial and pleural effusions were detected by ultrasound. Thoracic radiography showed an enlargement of both the atrium and the caudal vena cava.

The body of this female jaguar was 1.00 meter long for a body weight of 82 kg. Its heart weighed 0.312 kg and the corresponding heart weight / body weight (HW / BW) ratio was 0.0038. Another female jaguar, dead because of a hepatic haemangiosarcoma, was used as control and its body and heart weights were 76 kg and 0.183 kg, respectively, leading to a HW / BW of 0.0024. At necropsy, the heart was enlarged and globular in shape. On the cut surface, the left ventricle appeared diffusely hypertrophied and hypertrophy involved both the septum and large portions of the antero-lateral free wall. The lumen was considerably narrowed. The mean septum thickness was 0.93 cm whereas the left free wall thickness was 0.88 (the corresponding ratio was 1.056) in the case animal whereas the septum thickness, the left free wall and the calculated ratio in the control jaguar were 0.62 cm, 0.75 cm and 0.826 respectively (figure 2). The lungs were diffusely congested, oedematous and quite firm on palpation, and the trachea and bronchi contained a frothy fluid. Other pathological conditions such as left atrial thrombosis or any defective left-sided outflow disease such as aortic valve stenosis or dysplasia has been ruled out.

Microscopic examination of the affected heart revealed multifocal areas of strikingly disorganized cardiac muscle cells and interstitial myocardial fibrosis characterising HCM (figure 3). These areas were observed only in the septum and were not found in the left ventricular free wall. The wall of the intramural vessels was thickened and the lumen appeared narrowed. Using the picrosirius red stain coupled to polarization microscopy, the collagen type I fibres appeared red to
yellow stained whereas the collagen type III was seen as greenish stained fibres. Compared to the control jaguar, the amount of total collagen in the left ventricle and the collagen type I / collagen type III ratio were higher in the affected animal (figure 4).

**Discussion**

Clinical and necropsy findings supported the diagnosis of severe HCM [1]. The observed HW/BW ratios for the affected and control animals can be matched with the values already published for domestic cats with HCM and corresponding controls [6]. In domestic cats with asymmetric left ventricular hypertrophy, the ratio septum thickness to free wall thickness has been recorded to be 1.1 [7]. In the case reported here, this ratio calculated for the heart diseased jaguar was high (1.056 versus 0.826 in the control) and also suggested ventricular asymmetry. Nevertheless, at least in domestic cats with cardiac hypertrophy, the ratio septum thickness to free wall thickness varies from 0.8 to 1.1 [7].

The cardiac muscle cell disarray observed in this case was coincident with the Type I-A pattern characterized by adjacent cardiac muscle cells aligned perpendicularly to each other. This pattern of myocardium disorganization is by far the most frequently observed in cat’s HCM [4] and has been considered as relatively specific for feline HCM, although normal cats can also exhibit some limited disarrays of cardiac fibres [7].

Familial HCM accounts for the majority of feline HCM as in humans [12]. This cardiomyopathy has been related to inherited mutations in some genes coding for different sarcomere proteins in both humans and cats [4, 10]. But, the HCM disease process is not confined to sarcomere protein abnormalities but also involves connective tissue elements. In this way, it was recorded a marked increase of the amount of myocardium fibrillar collagen, particularly of the collagen type I, in this case report and this observation agrees with similar reports in humans [14]. The increment of collagen type I was often coupled with cardiac dysfunction [11]. To our knowledge, this is the first report of HCM in a wild animal. Consequently, this cardiomyopathy should be taken into account in the differential diagnosis of heart diseases or sudden death in the jaguar. Conservation of Latin American felids has been the primary focus of reproductive research and training programs conducted in Brazil, Mexico, and the USA [15]. But, the hereditary nature of HCM [4] should be considered in breeding programs leading to the conservation of captive or free-ranging jaguars.

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**References**


