**CASE REPORT**

**Malignant hypertension and retinopathy in a western lowland gorilla (Gorilla gorilla gorilla)**

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**Abstract**

**Background** A 34-year-old western lowland gorilla presented with peracute blindness.

**Methods** Clinical evaluation, diagnostic imaging, laboratory analyses, blood pressure measurements, and necropsy were performed.

**Results** The clinical and postmortem findings supported malignant hypertension.

**Conclusions** We describe a case of naturally occurring hypertensive encephalopathy and retinopathy in a gorilla.

**Introduction**

The sequelae of malignant hypertension, including hypertensive encephalopathy and retinopathy, have been described in a variety of species [7, 9, 16], but primary hypertension has been infrequently described in non-human primates [4, 11, 15]. This report describes the clinical and postmortem exam findings of malignant hypertension in a western lowland gorilla (Gorilla gorilla gorilla) at The North Carolina Zoological Park, Asheboro, North Carolina, USA. The North Carolina Zoological Park is accredited by the Association of Zoos and Aquariums, registered with the United States Department of Agriculture, and has an approved behavioral enrichment program. All work presented herein was conducted in compliance with appropriate animal care standards, regulations, and national laws.

**Case report**

A 34-year-old, non-pregnant, primiparous female, western lowland gorilla housed in an indoor outdoor exhibit in a mixed gender group was euthanized for acute blindness due to bilateral, complete retinal separation and concurrent quality of life concerns, including degenerative joint disease and other issues resulting from an approximate 25-year history of self-mutilation.

Over the years, numerous attempts were made to resolve the gorilla’s self-mutilation behavior. These included multiple plastic surgeries, behavioral enrichment, social grouping adjustments, exhibit changes, and trials of a variety of pharmaceuticals directed at pain management and/or behavior modification. A panel of experts comprised of primatologists, veterinarians, psychologists, and zoo personnel was involved in her behavioral treatment. Most of the attempts to correct her behavior had initial positive effects, but were short-lived. The gorilla was not on any of these medications during the period of interest to this case report.

During the approximate three months prior to euthanasia, the gorilla was evaluated for somnolence, head holding, and eye-squinting behaviors, as well as uveitis, cataracts, partial retinal detachment, and a chronic abdominal abscess with inguinal draining tracts. Elevated blood pressures (via oscillometric methodology)
were documented (Fig. 1) during anesthesia events over this three-month period. Therapy with enalapril maleate [2.5 mg (0.03 mg/kg) by mouth every 24 hours; Wockhardt USA, Parsippany, New Jersey] was initiated after two weeks and increased [2.5 mg (0.03 mg/kg) by mouth every 12 hours] approximately 1 month later, but no positive response was observed prior to euthanasia. The abscess was characterized via bacterial culture and computed tomography and was likely related to the chronic self-mutilation, which also included picking at the skin of the knees and ankles. The abscess was treated with oral and topical antimicrobials, in addition to more aggressive cleaning of the fistulous tracts during anesthetic events. In addition to enalapril, the gorilla also received opioid and non-steroidal anti-inflammatory medications for analgesia, as well as intravitreal steroid therapy. Over the three-month period, there were no significant findings in complete blood counts, serum biochemistry panels, or urinalysis results. Weight loss of approximately eight kilograms was noted.

Pathology
A board-certified veterinary pathologist performed a full necropsy and histopathologic examination. Body condition was poor. There was bilateral retinal detachment with intraocular hemorrhage (Fig. 2A). There was moderate concentric thickening of the left ventricle, with the left ventricular free wall, interventricular septum, and right ventricular free wall measuring 2.6 cm, 1.9 cm, and 0.4 cm, respectively (Fig. 2B). The abdominal abscess replaced most of the right ovary and right uterine horn.

Tissue samples were fixed in 10% neutral-buffered formalin, embedded in paraffin, sectioned at 5 μm, and stained with hematoxylin and eosin. Periodic acid-Schiff staining was used in selected tissues.

Small arteries and arterioles of the spinal cord, eye, gall bladder, liver, kidneys, deep dermis, gastrointestinal muscularis, mesentery, and the vasovasorum of great vessels showed mild to marked thickening, resulting in luminal narrowing due to expansion of the tunica media and intima by concentric rings of plump smooth muscle cells and fewer fibroblasts ('onion skin' lesions). Within the walls of many affected arteries and arterioles, there were variable numbers of diffusely distributed lymphocytes, macrophages, plasma cells, neutrophils, and erythrocytes. Sparse karyorrhectic debris was present within the areas of inflammation, and there were occasional intramural accumulations of brightly eosinophilic (fibrin) material (necrotizing arteriolitis). Rare thrombosis was observed. Mild intramyocardial arteriosclerosis was observed in the heart. Vascular lesions were most severe in the choroid and meninges (Fig. 2C), renal lesions were variable in severity (Fig. 2D), and larger arteries and veins throughout the body were spared.

![Fig. 1 Non-invasive, oscillometric blood pressure measurements of a 34 year old female, western lowland gorilla taken within the three months prior to euthanasia. A range of measurement is given for anesthetic events where multiple blood pressure measurements were recorded. Systolic pressures are symbolized by circles and diastolic pressures by triangles. The gorilla was anesthetized with intramuscular ketamine (Fort Dodge Animal Health, Fort Dodge, Iowai, midazolam (Hospira, Inc., Lake Forest, Illinois), and inhaled isoflurane (Abbott Animal Health, Abbott Park, Illinois) for the first and fourth procedures. The second, third, and fifth procedures utilized oral diazepam (Watson Laboratories, Inc., Parsippany, New Jersey) and intramuscular ketamine and midazolam.](image-url)
Discussion

In humans, sustained systolic blood pressures greater than 139 mmHg or diastolic blood pressures greater than 89 mmHg are considered hypertensive [3, 12]. Hypertension may be primary (i.e., essential or idiopathic) or secondary to disease processes, such as those involving the renal, endocrine, and neurologic systems, as well as pregnancy and certain pharmaceuticals [1, 3, 12]. Vascular lesions in chronic low to moderate hypertension tend to be characterized by pink hyaline thickening of arterial and arteriolar walls (hyaline arteriolosclerosis) [8]. Hypertension is considered malignant when systolic blood pressure exceeds 200 mmHg or diastolic pressure exceeds 120 mmHg [12]. The vascular lesions in malignant hypertension are characterized by concentric expansion of the smooth muscle cells and basement membranes resulting in an ‘onion skin’ appearance (hyperplastic arteriolosclerosis) [8, 12]. In severe cases, malignant hypertension is associated with necrosis of the vascular wall and intramural accumulations of fibrin (necrotizing arteriolitis); intravascular thrombosis and regional ischemia may also be observed [5, 12]. Concurrent inflammation, reminiscent of that observed in immune-mediated vasculopathies, is often briefly noted or documented in both hyaline and hyperplastic arteriolosclerosis, although a specific range of severity is not reported [3, 8, 16].

Formation of vascular lesions in hypertension is believed to occur when a precipitous or sustained increase in blood pressure exceeds the autoregulatory capacity of smaller arteries and arterioles. Weaker areas of the vessel wall begin to dilate (‘sausage string’ appearance) causing disruption of endothelial tight junctions [3, 5, 16]. There is increased endothelial expression of cell adhesion molecules and inflammatory cytokines and subsequent leukocyte adhesion and migration. The combination of mechanical and inflammatory injury allows protein leakage into the vascular wall and triggers the hyperplastic response [16].

In this case, systolic and diastolic pressures exceeded the criteria for malignant hypertension, which is reflected by hyperplastic arteriolosclerosis with occasional necrotizing arteriolitis observed in arteries and arterioles throughout the body. The hypertension was presumed to be primary given the absence of endocrine disease and normal serum biochemical renal values. This animal’s full brother and father also had unspecified cardiac disease. Primary hypertension is found in 95% of human hypertension cases and is likely caused by genetic and environmental factors [12].
Hypertension results in a myriad of pathologic changes in renal, neurologic, and ocular systems, in addition to the vascular system [1, 12]. Cardiac measurements in this gorilla exceeded documented findings for similarly aged female gorillas (1.4 cm mean for both left ventricular posterior wall and interventricular septum) [13], as well as reported measurements for larger, male gorillas (mean left ventricular posterior wall width 1.14 1.79 cm) [6], and are consistent with compensatory left ventricular hypertrophy [14]. Retinal detachment and renal vascular lesions are frequently described sequelae to uncontrolled hypertension in other species, such as humans, woolly monkeys, kangaroos, cats, and dogs [4, 7, 9, 10, 15]. Sudden, severe elevations in blood pressure are known to result in acute neurologic symptoms (i.e., hypertensive encephalopathy) in humans, rats, and cats, although the intracranial edema usually associated with these cases was not present here [2, 3, 5, 16].

The decision to euthanize this gorilla was based on multiple formal quality of life evaluations, which considered concurrent conditions and the severity of symptoms associated with hypertension. Given her uncontrolled hypertension, the prognosis for retinal reattachment and restoration of vision was very poor. Housing the animal singly post-enucleation or exenteration was not considered an option due to her behavioral issues. Aggressive, early treatment of benign, primary hypertension in gorillas, possibly necessitating multi-drug therapy, is likely important in preventing disease progression [11].

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References