

# The Frequency of Gastric Amyloidosis in Baboons. A 22-year Survey at a Large Primate Facility

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**Abstract.** *Background: Systemic amyloidosis, caused by abnormal tissue accretion of plasma proteins, affects several organs of the gastrointestinal (GI) tract. Gastric amyloidosis, rare in humans, has only been reported once in animals. Materials and Methods: Gastric amyloidosis was sought for in baboons with systemic amyloidosis. Results: During the past 22 years (between January 1986 and January 2007) a mean of 3,315 baboons/year (range 2,578-3,931) were housed at the Southwest National Primate Research Center. Gastric amyloidosis was found in 9 (10.2%) of the 88 baboons having a diagnosis of systemic amyloidosis. Consequently, the prevalence of gastric amyloidosis occurring since 1986 at this facility was 0.41 baboons/year. Gastric amyloid deposits were found in the interstitial aspect of the lamina propria, replacing normal mucosal structures, in the submucosal stroma along the interface with the muscularis mucosae and in the interstitial tissue of submucosal lymphoid aggregates. In one of the animals, lumps of amyloid deposits with giant cells were found in the gastric mucosa. Conclusion: Baboons with systemic amyloidosis usually show increasing frequency of amyloid deposits in the liver, large intestine, lymph nodes, spleen and the small intestine. We now demonstrate that it may also involve the stomach. Why certain organs of the GI tract in baboons are more susceptible than others to be affected by the process of systemic amyloidosis remains unexplained. The apparent natural resistance of the stomach of baboons to be affected by systemic amyloidosis deserves further investigation. The review of the literature indicates that this is only the second report on gastric amyloidosis in baboons.*

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Amyloidosis is a disease caused by abnormal tissue accretion mostly of insoluble plasma proteins conveyed by fibrillogenesis. The disease can be organ specific. When systemic, it affects several organs such as the heart, liver, spleen, kidneys, lymph nodes, adrenals, thyroid and the gastrointestinal (GI) tract.

Amyloidosis affects not only humans but also animals. Naumenko and Krylova (1) studied 133 cases of amyloidosis in non-human primates, namely in macaques (*Macaca mulatta*, *Macaca nemestrina* and *Macaca fascicularis*). The liver, the spleen and the pancreas were the most commonly affected organs. Hubbard *et al.* (2) found amyloidosis in the liver, the pancreas and the spleen in 12 chimpanzees (*Pan troglodytes*) and in 40 baboons (3). Slattum *et al.* (4) detected at necropsy that 75% of 248 of pigtailed macaques had amyloidosis in the GI tract, mostly in the small bowel. Blanchard *et al.* (5) noticed amyloidosis in the liver, the small and the large intestine among 57 rhesus monkeys. Other authors (6-11) also reported the occurrence of amyloidosis in non-human primates. Recently, cerebrovascular amyloidosis was found in mice (12, 13).

To date, only one case of gastric amyloidosis has been reported (3) in the publications of systemic amyloidosis in animals (1-13).

Recently, while reviewing the autopsy material from baboons having an initial diagnosis of systemic amyloidosis we noticed interstitial (14) deposits of amyloid in the stomach of some of the animals. The aim of this work was to assess the frequency of gastric amyloidosis in these animals.

## Materials and Methods

Since 1986, all cases of baboons having a diagnosis of systemic amyloidosis have been filed at this facility. Systemic amyloidosis secondary to chronic inflammation is the most common form in animals (2). Essentially, all baboons with amyloidosis had chronic low-grade enteric disease due to nematode and protozoan parasites, as well as chronic bacterial and viral infections.

The baboon does not have true *Helicobacter pylori* but spiral-shaped bacteria which are considered to be part of the normal gastric flora.

The baboons were members of colonies at the Southwest National Primate Research Center, Southwest Foundation for

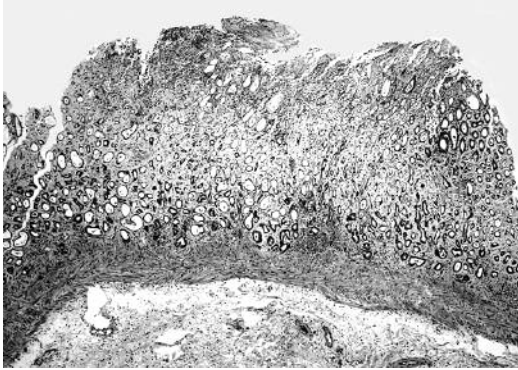


Figure 1. Fundic gastric mucosa partially replaced by interstitial deposits of amyloid (H&E  $\times 6$ ; baboon).

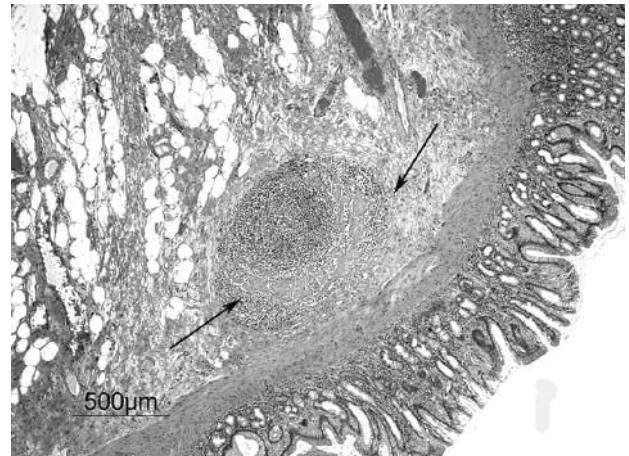


Figure 2. Submucosal lymphoid aggregate (between arrows) partially replaced by amyloid deposits (H&E  $\times 4$ ; baboon).

Biomedical Research. The housing conditions have been reported elsewhere (2, 3). Briefly, the animals were housed in metal and concrete indoor-outdoor cages and were fed commercial monkey diets occasionally supplemented with a variety of fruit and vegetables. Water was available *ad libitum*. Baboons were euthanized with a commercial barbiturate euthanasia agent or died naturally. On necropsy, tissue samples were fixed in 10% neutral buffered formalin, processed conventionally, embedded in paraffin, cut at 5  $\mu\text{m}$ , stained with hematoxylin and eosin (H&E) or Congo Red and evaluated by light microscopy. All procedures were carried out in accordance with the Institutional Animal Care and Use Committee. Histological sections from baboons having a diagnosis of amyloidosis were stained with H&E. Sections stained with Congo Red were analyzed under polarized light.

## Results

**Frequency of gastric amyloidosis.** A total of 88 baboons with an initial diagnosis of amyloidosis were retrieved from the files. Gastric amyloidosis was present in 9 (10.2%) of the 88 baboons.

**Prevalence of gastric amyloidosis.** During the past 22 years (between January 1986 and January 2007, a mean of 3,315 baboons/year (range 2,578-3,931 baboons/year) were housed at the Southwest National Primate Research Center. The prevalence (defined as the number of cases of an illness or condition that exists at a particular time in a defined population) of gastric amyloidosis occurring since 1986 at this facility was 0.41 baboons/year.

**Histological features.** In H&E-stained sections, amyloid appears as a pink, hyalinized material. Amyloid deposits were found in the interstitial aspect of the *lamina propria* replacing the normal structures of the mucosa (Figure 1). Amyloid material was also seen in the submucosal stroma along the interface with the *muscularis mucosae* and in the interstitial tissue of lymphoid aggregates in the submucosa (Figure 2). In one of the animals, lumps of amyloid deposits

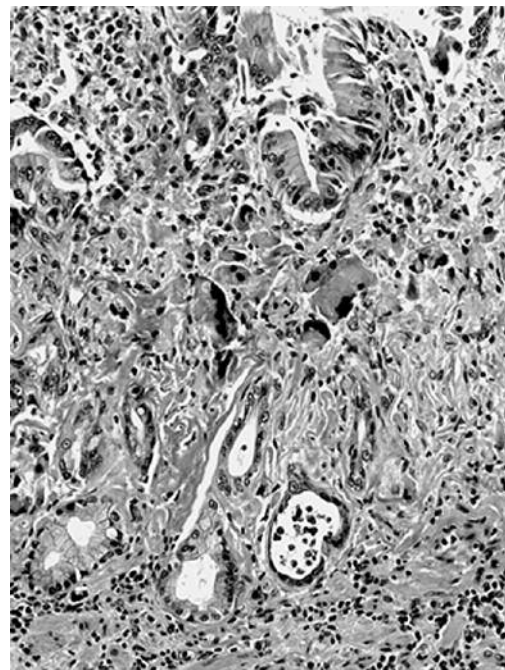


Figure 3. Gastric mucosa partially replaced by interstitial amyloid deposits showing giant cells (H&E  $\times 30$ ; baboon).

with giant cells were found in the gastric mucosa (Figure 3). Sections with gastric amyloidosis stained with Congo Red demonstrated, in polarized light, the characteristic apple-green birefringence in affected areas.

## Discussion

In a comprehensive study of the pathology of amyloidosis in animals, Zschesche and Jakob (15) reported amyloidosis in fishes, amphibians, reptiles, birds, rodents (gerbils, guinea

pigs, nutria), dogs, stone martens, minks, domestic cats, cattle, marsupialia, monkeys and other mammals. Several organs were found to be involved. No case of gastric amyloidosis was reported in those animals (15).

Baboons with systemic amyloidosis usually show increasing frequency of amyloid deposits in the liver, large intestine, lymph nodes, spleen and the small intestine. We now demonstrate that this may also be found in the stomach.

In humans, single cases of gastric amyloidosis, either as a solitary finding or as part of a systemic amyloidosis evolving in patients with chronic diseases such as rheumatoid arthritis or plasmocytoma have been reported (16-20), including localized masses of amyloid, known as tumoral amyloid (21). Tumoral amyloid often contains giant cells. We found one such a case among the 9 baboons having systemic amyloidosis.

Why certain organs of the GI tract in baboons with systemic amyloidosis are more susceptible than others to be affected by the process, remains unexplained. Notwithstanding, in this population of baboons, the apparent natural resistance of the stomach to being affected by systemic amyloidosis deserves further investigation.

The review of the literature indicates that this is the second report on gastric amyloidosis in baboons.

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