

Jejunal Intussusception and Small Bowel Transmural Infarction in a Baboon (*Papio hamadryas anubis*)

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A 4.3-y-old, colony-bred female baboon (*Papio hamadryas anubis*) of low social rank and exhibiting no clinically significant signs of illness or distress was found dead at the Oklahoma University Health Sciences Center baboon breeding facility at El Reno, OK. Prior to death she exhibited excessive grooming behavior both toward herself and other baboons. In addition, she was consistently shy, timid, reclusive, and prone to minimal sustained movement (that is, generally lethargic behavior). Animals of low social rank typically exhibit some degree of these behaviors in order to avoid surplus interactions with other animals within their groups, which can lead to conflict and injury. Accordingly, her death was surprising in view of the apparent lack of clinical signs. Necropsy established the cause for death as systemic shock with resultant cardiovascular collapse resulting from a massive jejunal intussusception. This intussusception and resulting entrapment of the jejunal mesenteric vasculature caused total occlusion of the small bowel blood supply, with resulting hemorrhage and ischemic necrosis (small bowel infarction). Jejunal intussusceptions generally are considered to be uncommon and therefore are rarely reported in either the veterinary or human literature. Of special interest was the cause for this intussusception, determined to have been a large hairball located at the most proximal portion of the jejunum. Extending from this hairball and traversing essentially the entire length of the jejunum was a braided strand of hair acting as a string foreign body about which the intussusception formed. In light of our findings we suggest that animals of low social rank exhibiting excessive grooming behavior and lethargy might merit clinical evaluation to rule out possible abdominal disorders.

Case Report

On 5 March 2005, a 4.3-y-old colony-reared, parasite-free, female baboon was found dead in the southeast corral of the Oklahoma University Health Sciences Center baboon breeding facility located at the El Reno Science Park in El Reno, OK. At this facility, which is accredited by the Association for the Assessment and Accreditation of Laboratory Care, International, and registered with the United States Department of Agriculture, animals are housed in 4 large indoor-outdoor corrals which have been previously described.³ Briefly, each corral houses a 'gang' of baboons, with each gang consisting of 4 to 5 adult breeding males, approximately 30 adult breeding-age females, and 15 to 30 juveniles. Space available for animal use (per gang) exceeds requirements established by the *Guide for the Care and Use of Laboratory Animals*.¹⁴ In addition, for enrichment purposes each corral area features a variety of large and small vertical climbing structures, concrete culverts for animal separation, and a variety of enrichment manipulanda which are provided on a rotating basis. All animals receive daily veterinary observation and regular health evaluation, as well as inspection and observation by animal technicians. They receive Harlan Teklad Global 20% Primate Diet 2050 (Indianapolis, IN) free choice morning and evening and seasonal fresh fruits and vegetables daily. All food stuffs are spread randomly throughout each gang so that all animals have full access to the food. Water is provided ad libitum from multiple automatic waters that are checked regularly to ensure proper operation. The majority of baboons at

this facility are of the olive subspecies (*Papio hamadryas anubis*), with the possibility that some could have mixed ancestry with the yellow baboon (*P. h. cynocephalus*).

The history of this particular baboon was unexceptional prior to her death, but records confirmed that she frequently was seen grooming herself and other animals. At no time was she observed to be in obvious pain or discomfort, exhibit vomiting or hematemesis, demonstrate diarrhea, or appear cachetic or febrile. However, evaluation of this baboon was complicated by the fact that her social ranking within her gang was very low. Animals of low social position are predisposed to a variety of behavioral affects, some of which can lead to medical conditions. Purely behavioral affects can consist of reduced movement or inconspicuous behavioral displays in order to avoid conflict with higher ranking members of a given gang.^{15,16} Affects that relate to stress can cause a variety of stereotypic behaviors, such as self-mutilation and excessive grooming, and both of these behaviors can have clinical consequences.^{4,5,9,10,18} Accordingly, this baboon was essentially a 'background animal' that generally was found sequestered in the enrichment culverts or sitting quietly in a far corner of her corral. At the time of her death, she was in good apparent flesh and approximately 24 h prior to death was observed eating and drinking.

Pathologic Findings

Upon discovery, the dead animal was transported to the institutional animal resources facility in Oklahoma City, OK, for necropsy. On gross external examination, the only noteworthy finding was a moderately sized palpable mass in the midabdomen. There were no signs of trauma or physical injury. The animal was in good flesh and had an adequate hair coat. There

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Figure 1. Jejunal intussusception with congestion and vascular arcade entrapment.

were areas of thinning hair from excessive grooming, but the hair shafts, epidermis, and dermis were of normal morphology, with no indication of any chronic protein-losing enteropathy.

Examination of abdominal contents revealed massive congestion of the small bowel, especially the jejunum and associated jejunal vascular arcades, resulting from a nonreducible intussusception of approximately 15 cm (Figure 1). Dissection into the intussusception revealed a large hair ball (Figure 2) at the proximal terminus of the jejunum. Extending from this feature and traversing essentially the entire length of the affected jejunum was a braided and plicated (that is, rope-like) mass of hair approximately 15.0 cm in length and 0.5 cm in diameter (Figure 3). The affected small bowel region contained large quantities of clotted blood and gas.

Examinations of thoracic contents were unremarkable. There was no evidence of either fibrinous pleuritis or peritonitis. Dissection into associated and adjacent abdominal vessels revealed no detectable evidence for either thrombus or embolism formation. Organ and tissue specimens were collected, fixed in hematoxylin and eosin, sectioned (5.0 μ m), and examined. Tissues (liver, spleen, and so on) were unremarkable, with the exception of the lungs and small intestine, specifically the area corresponding to the jejunum. The entire length of the jejunum (Figure 4) consisted of a single massive transmural necrotic and hemorrhagic infarction. Numerous colonies of large, linear, rod-shaped bacteria were present. The lungs exhibited marked areas of congestion with mild capillary leakage. No microbiologic or toxicologic assays were performed.

Discussion

Regardless of the species, intussusceptions in juveniles and adults^{2,12} are due to some predisposing cause (for example, in adults, hypertrophied lymphoid tissue, parasites, masses, and foreign bodies), whereas for those in infants, usually no cause is identified. Signs consistent with this syndrome are those of abdominal pain, rectal bleeding, vomiting, hematemesis, lethargy, and diarrhea or constipation.^{1,13,19,20} In this case, the predisposing cause was essentially a 'hair-string' foreign body anchored to and uncoiling from a hairball lodged in the most proximal portion of the jejunum.

The pathophysiologic mechanism for a foreign body-induced intussusception is as follows. Peristaltic waves, generated by the small bowel, continue to move the irritant (in this case, string) along and through the length of the bowel segment.^{6,17}



Figure 2. Hairball removed from the proximal portion of the jejunum.

The presence of the string predisposes the small bowel for a variety of consequences. In one scenario, the string serves as an irritant and prompts one segment of the small bowel to become constricted by a wave of peristalsis and suddenly telescope into the immediately distal segment of the bowel. Once trapped, the invaginated segment is propelled by peristalsis further into the distal segment.^{6,17} In addition to the telescoping action of the bowel, the attached jejunal mesentery and its vascular supply also are entrapped. This entrapment of the mesenteric vasculature causes obstruction of blood flow to the small bowel. However, there are several additional causes for the obstruction of blood flow to the small bowel that need to be mentioned. Blood flow can be interrupted due to the presence of masses, thrombus formation, or the arrival of an embolus.⁸

Regardless of the etiology contributing to small bowel blood-flow interruption, infarction of the small bowel can occur.^{6,17} Infarction is defined as an area of ischemic necrosis within an organ or tissue that is produced by the occlusion of either its arterial or venous drainage.^{6,8} As a result of infarction, the intestinal mucosa rapidly becomes necrotic and decomposes, causing blood loss into the intestinal lumen (that is, hemorrhagic bowel).⁸

Another scenario involves the movement of the string through the small bowel in such a manner that the string acts as a cutting wire that 'saws' through to the mesenteric side of the intestine. Once the intestinal wall is breached, intestinal contents (for example, bacteria, endotoxin, and metabolic waste products) are released into the abdominal space, with resultant enterotoxemia and fibrinous peritonitis.^{6,17} A corollary to this scenario includes the elaboration of neurogenic, neuromuscular, diarrhea, or enteritis toxin(s) by invading bacteria, such as those produced by clostridial species.^{6,7,11,17} A final possible scenario involves a combination of the previously discussed situations, in which both intussusception and breach of the intestinal wall occur. In this scenario, hemorrhagic enteritis and hemorrhagic bowel would most likely be present with fibrinous peritonitis.

We base our diagnosis of foreign body induced intussusception in this baboon on the following facts. By necropsy, there was no evidence of either fibrinous peritonitis or pleuritis or of hemorrhagic diarrhea or enteritis. At 24 h prior to death and at gross postmortem examination, there was no evidence of diarrhea, rectal staining, or rectal blood. There were large quantities of clotted blood in the affected portion of the jejunum. This blood was present both in the jejunal lumen (hemorrhage) and within the walls of the jejunum (intramural congestion). Approximately

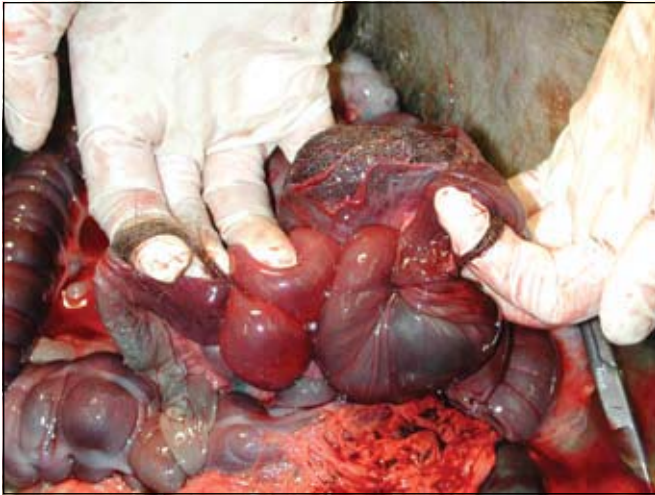


Figure 3. Braided and plicated rope-like mass of hair (length, 15.0 cm in length; diameter, 0.5 cm) originating from the jejunal hairball and traversing the length of the intussuscepted region of the jejunum.

24 h prior to death, the animal was observed to eat and drink, behave in character, and exhibit no signs suggestive of pain or discomfort. In light of these findings, we suggest that the string served as an irritant, causing an acute, large, jejunal intussusception to occur. This intussusception trapped the adjacent jejunal mesentery and its associated microvascular supply, resulting in ischemic infarction of the jejunum. As a result of this infarction, the intestinal mucosa rapidly was compromised due to loss of microvascular blood supply. With inadequate blood supply, tissues became ischemic, and necrosis ensued. Death ensued acutely or peracutely from hypovolemic shock and associated total cardiovascular collapse due to rapid blood loss into the intestinal lumen from necrosed jejunal vessels/tissues and compromised adjacent vessels/tissues.^{6,17}

We suggest that the magnitude of the intussusception was due to the length of string that traversed the jejunum before the intussusception occurred. It is generally thought^{12,17} that the most common site for intussusceptions is the ileocecal valve region of the small intestine. In our literature search, we found several reports in the veterinary literature of intussusceptions at the ileocecal location but could find no references for a jejunal location. By widening our search to include human literature we discovered that, indeed, jejunal intussusceptions are generally thought to be uncommon. Since 1914, only 200 human cases have been reported worldwide, and there have been only 16 reported and confirmed cases at the Mayo Clinic (Rochester, MN).¹ Typically there is high mortality (as high as approximately 50%) associated with these intussusceptions, independent of treatment.¹ Currently the only effective treatment is immediate surgery to reduce or resect the intussusception (within 48 h or less) from the occurrence of the earliest signs of abdominal pain.^{1,17}

Unfortunately, for this baboon, there were no clearly observable or recognizable signs suggestive of the presence of any abdominal pathology. Signs could have been present, but if so, were too subtle to be detected, given the reclusive nature and behavior of this animal (that is, due to her low social rank). The excessive degree to which she groomed both herself and others contributed to the formation of the large hairball that eventually led to the creation of a fatal intussusception. Animals of low social rank often experience increased levels of stress.^{4,5,9,10,18} To relieve this stress, they often exhibit stereotypic behavior(s), such as self-mutilation, repetitive body motions (for example, rocking),

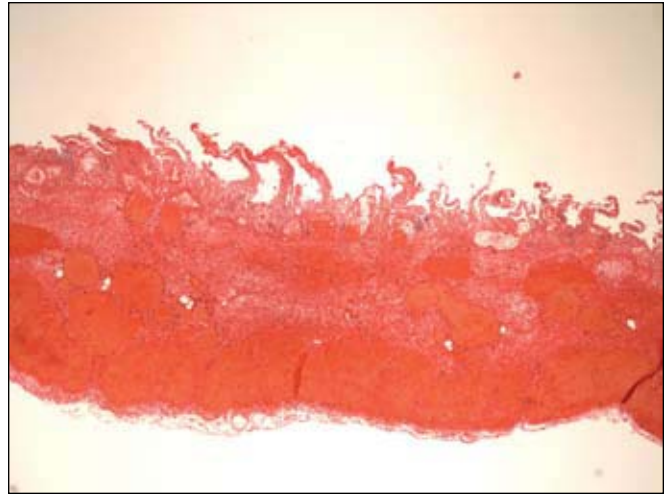


Figure 4. Transmurial infarction characterized by acute hemorrhagic necrosis involving the full thickness of the small bowel wall. Much of the mucosal layer was lost, with only a small remnant of villi. Hematoxylin and eosin; original magnification, 40 \times .

hair pulling, and excessive grooming.^{9,15,16,18} At our facility we see socially low ranking animals exhibiting any and all of these behaviors without their suffering detectable clinical problems. They also cycle regularly, conceive, and deliver healthy infants at term. It was noted that this animal was reclusive by nature and prone to excessive grooming. However, she appeared to be in good health and was not directly threatened by any other animal. Furthermore, within the constraints of her reserved nature she actively gathered food, drank water, had a regular estrus cycle, and appeared to urinate and defecate normally.

In general this animal appeared to basically fit the profile of a socially low-ranking animal that relieved stress through some type of stereotypic behavior, which in this case consisted of excessive grooming.^{9,10,15,16,18} However, we now suggest that nonhuman primate facilities may need to more closely observe animals of low social rank that exhibit a combination of signs consisting of the specific stereotypic behavior of excessive grooming and the presence of lethargic or reclusive behavior. As in the case we present, these signs could be consistent with the presence of a string foreign body originating from a hairball resulting from excessive grooming. This foreign body could result in any of several scenarios, such as intussusception, intestinal rupture, or a combination of these events, any or all of which can have serious clinical implications.

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