Standards of Care: Ferret Medicine

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Common behavior questions

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- Why can't I get my adult ferret to try this new food I bought? I've purchased a number of different foods for variety but he/she just won't try them.
  - Kits (young, juvenile ferrets) of wild polecats have a critical period of learning the scent of prey (olfactory imprinting) between 60 and 90 days of age. As adults, they will actively search for prey with which they were familiarized during this critical time period and will ignore other prey or food smells. This may explain why many pet ferrets will eat only one type of diet and why kits exposed to only one brand of food during the first 3-6 months of age may be opposed to dietary changes later in life. It is therefore recommended that juvenile ferret be offered a variety of foods during their first six months of life in order to prevent this dietary selectivity or olfactory imprinting.
- Why are my two adult ferrets suddenly fighting? They used to get along so well.
  - Hormonal derangements including elevations in sex hormones can occur secondary to adrenal disease. These imbalances may lead to increased aggressive behavior even in neutered and spayed ferrets. These behaviors include neck gripping, mounting and wrestling that leads to fighting and nipping behavior.
- Why does my ferret love it when I bounce a rubber ball to play with? He/she really goes crazy and grabs the ball and shakes it.
  - The ferret at play demonstrates various behaviors that stem from normal behaviors we might observe in the wild ferret or polecat. Predators stalk and chase their prey as part of normal hunting behavior. Observe the ferret playing with a hard rubber ball or squeaky toy, and you will see the same type of behavior. A rolling or bouncing ball captivates the ferret, which immediately begins the hunt. The ball is aggressively pursued until the ferret captures it by grabbing hold, then biting and shaking it as if it were prey.
- Why does my ferret grind its teeth when it isn't feeling well?
  - Ferrets may grind their teeth in response to pain. A painful abdomen is not uncommon in the ferret and may result from gastrointestinal diseases such as bacterial infections, ulcers, stomach hairballs or ingested foreign materials that get lodged in the small intestines. Owners often report that the ferret is hunched-up with an arched back, immobile or walking with a stilted gait and is grinding its teeth-- all common signs of abdominal pain.

Basic facts

- Males = 'hobs'
- Females = 'jills'
- Babies = 'kits'
- Puberty = 4 - 9 months of age.
- Hobs typically weigh between 0.8 and 2.5 kg. Jills weigh between 0.6 and 1.2 kg. Many domestic ferrets mimic their wild counterparts with seasonal weight fluctuations. Body weight decreases during the spring (longer photoperiod) and gained back as subcutaneous fat storage in preparation for winter. This normal weight fluctuation can be up to 40% difference.
- Ferrets are induced ovulators and have a gestation period of 42-44 days.
- Average litter size = 8 (7-14)
- Kits are weaned at 4 to 8 weeks. The eyes and ears open about 32- 34 days after birth.
- Fur has a fine undercoat and larger, coarser guard hairs.
- Ferrets sleep very soundly and can sleep up to 18 hours per day.
- Body Temperature = 37.8 – 38.8 degrees centigrade (100.6 - 102 degrees F)
- Respiration = 33-36 breaths per minute
- Heart rate = 210-245 bpm
- Blood volume = 60 - 80 ml/kg (approximately 5 – 7 % body weight).
- Blood Pressure (under anesthesia): systolic 90-120 mmHG
- Urine pH = 6.5 – 7.5.
- QRS complex = 1.84 +/- 0.61 mV lead II
- Life span = 5 - 10 years average. Eight years is the more common.
- Heat loss by panting = very heat intolerant. Temperatures over 90 degrees can be fatal.
- Dental formula = $\frac{3\ 1\ 3\ 1}{3\ 1\ 3\ 2}$
- Deciduous teeth erupt at 14 days and permanent canines at 47 - 52 days.
- Vertebral column formula is C7, T15, L5 (6 or 7), S3, and Cx 18

Nutrition

Ferrets are true carnivores; their diet must consist mainly of meat and animal products. For maintenance, ferrets may consume between 200 and 300 kcal/kg body weight daily. A quality ferret diet should be 35 to 38% crude protein and 18 to 22% fat. When reading the pet food label, the first several items listed should be animal proteins such as meat or poultry, or meat or poultry meals or their by-products. Wysong (Wysong Corporation, Midland, MI) produces several commercial ferret foods that are high protein, high fat and low fiber and appropriate for the pet ferret. Many veterinarians advocate meeting the ferret's nutritionals needs through whole prey diets that imitate what a ferret would be eating in its natural environment. Nutritional support is a key element in the therapy of ferrets that are recovering from debilitating disease. Many ferrets can be syringe fed a variety of recipes that help meet their caloric needs. Ferrets will typically accept 15-30 ml per feeding over a period of time. The following formulas have been advocated for use in syringe feeding ferrets:

Oxbow Animal Health: Carnivore Care
Lafeber Company : Emeraid® Exotic Carnivore
Hill's Pet Nutrition a/d.

Esophagostomy tube placement

Placement of the esophagostomy tube is simple and the technique is similar to that used in felines. A 10 French Sovereign red rubber feeding tube (Sherwood Medical) is measured from the left side of the neck to approximately the 9-10 rib space (2/3 way to stomach). Feeding tubes can be left in place for up to six weeks with weekly bandage changes. For extended care owners can be easily taught to feed and medicate their ferrets at home.

Restraint, specimen collection and catheter placement

As needed, scruff the animal's skin over the back of the neck while supporting the back legs. With this hold most ferret become very relaxed and the veterinarian can proceed with an oral exam, ear exam and cleaning, nail trim or other procedures that require minimum restraint.

Venipuncture

Vena cava approach: Place the ferret on its back, extend forelimbs caudally. Enter the notch between the first rib and manubrium on the right side. Advance needle slowly while applying even negative pressure until the vena cava or other great vessels of the heart are pierced and blood appears in the hub. Many veterinarians prefer to use isoflurane or sevoflurane anesthesia in order to restrain ferrets for vena cava venipuncture.

Cephalic or Lateral Saphenous Veins: For small volumes of blood (i.e.; to check a blood glucose) the lateral saphenous or cephalic veins work well using a 27ga (0.41mm) ½ cc tuberculin syringe.

Subcutaneous fluids

For non-critical cases, bolus subcutaneous fluids at a dose of 75-100 ml/kg divided q8-12h.

Intravenous catheterization

A standard 24 (0.56mm) or 26 (0.46mm) gauge IV catheter can be placed in the cephalic vein of the foreleg with relative ease. Maintenance fluid requirements in the adult ferret are estimated at 75-100ml/kg/day.

Intraosseus catheterization

A 22 gauge (0.72mm) 3.81cm spinal needle is lined up parallel to the shaft of the femur. The skin over the greater trochanter is pierced and the needle advanced to the intratrochanteric fossa. The needle is then twisted to pierce the bone and advanced. Once placed, butterfly tape the catheter and suture to the adjacent skin.

Urinary catheterization

Urethral obstruction occurs in the male ferret as a result of prostatic disease/hyperplasia secondary to adrenal disease or urethral obstruction from urinary tract calculi. Passing a urethral catheter can be a challenge in a male ferret due to the small diameter of the urethra, the 'J' shaped os penis, and the sharp turn of the urethra over the pelvic bone. Global Medical Products makes a 4 French silicone catheter called a Slippery Sam. Using saline and a 22 ga (0.72mm) Teflon IV catheter (without needle) can be used to flush and dilate the urethral opening which aids in its identification thus easing the introduction of the urinary catheter.

Vaccination

Rabies

Ferrets are susceptible to the rabies virus. The only approved rabies vaccine is Imrab3 by Merial. Initial vaccination at 3 months of age; give booster vaccinations annually. Titers develop within 30 days of vaccination.

Canine distemper

PureVax Ferret Distemper by Merial is approved for prevention of canine distemper in the ferret. The PureVax product is made via recombinant technology in order to lessen vaccine reactions.

Vaccine reactions

Vaccine reactions are not uncommon in the ferret; most commonly an anaphylactic-like reaction occurring within minutes of vaccination. Reactions may include weakness, trembling, vomiting and diarrhea, respiratory distress, evidence of pulmonary edema, erythematous skin, tail piloerection, high fever, circulatory collapse and even death.

Treatment of vaccine reaction depends on the severity of the reaction and includes diphenhydramine hydrochloride, epinephrine, famotidine and fluid therapy. Several strategies have been suggested for the prevention of vaccine reactions in ferrets:

Do not give more than one vaccine at a time. Separate vaccines by a three week interval.

Premedication of ferrets with diphenhydramine. Most veterinarians advocate a pre-vaccine injection of diphenhydramine IM to prevent or decrease the seriousnesss of vaccine reactions.

Follow vaccination with an in-clinic observation period. Most practitioners recommend an observation period of 15 minutes with owners being directed to watch for signs associated with a vaccine reaction.

Heartworm

(Dirofilaria immitis) infection in the ferret has been reported in natural as well as experimental settings. The lifecycle and transmission of the parasite is similar to the dog. Lower worm burdens (1-5 adults) cause severe disease in ferrets due to the small size of the heart. All ferrets in heartworm endemic areas are at risk of infection. Signs of heartworm disease include dyspnea, cachexia, lethargy, pulmonary congestion, ascites, coughing, and sudden death. The diagnosis of heartworm disease in ferrets is based on clinical signs, radiography, echocardiography, and results of antigen and microfilaria testing.

Gastrointestinal disease

History

- Has there been a diet change?
- Any new ferrets added to the household?
- Is your ferret allowed to free-roam unsupervised?
- Has your ferret been grinding its teeth or pawing at the mouth?
- Is your ferret vomiting and if so how often?
- What is the character of the diarrhea and how long has it been going on?
- Is your ferret still eating or drinking?

Physical exam

- Hydration status - evaluate and determine best method to correct dehydration.
- Body temperature - a subnormal temperature may be an indication of poor circulation as a result of an intestinal blockage or severe Metabolic disease. An elevated body temperature may indicate an infectious etiology.
- Abdominal palpation- check for foreign bodies, hairballs, abdominal pain, splenomegaly or other organomegaly.
- Mucous membranes- color and tackiness.

Diagnostics

- Fecal (floatation, direct exam, cytology) - Check for intestinal parasites, bacterial flora and evidence of white blood cells.
- CBC and blood chemistries- important to check for hypoglycemia, metabolic disease
- Radiographs- Plain films followed by barium series when indicated.
- Ultrasonography- assess for foreign bodies, organomegaly, neoplasia.

Gastrointestinal obstruction

Gastrointestinal obstruction is a common problem, especially in ferrets less than two years of age that have a tendency to ingest soft rubber objects of any kind. This behavior tends to greatly decrease in mature ferrets. In the older animal, obstruction with trichobezoars becomes a more frequent cause of gastrointestinal obstructive disease. In ferrets, the clinical signs associated with GI foreign bodies vary greatly. In cases of gastric foreign bodies that are not causing acute obstructive disease, the signs can be vague and include any combination of the following: intermittent anorexia, decreased volume of stools, tarry stools, depression, gradual weight loss, pawing at the mouth, teeth grinding and salivation. Vomiting does occur, but is not as frequent a finding as in dogs or cats with gastric foreign bodies. The ferret may become irritable and aggressive due to chronic pain. When a complete obstruction occurs, whether it is at the pylorus or in the small intestine, the signs are much more dramatic. The patient will exhibit severe depression and dehydration, vomiting is more common, stools are scant and tarry and abdominal distention (caused primarily by a gas-filled stomach) may be present. These patients also demonstrate abdominal pain/splinting and may grind their teeth and paw at their mouths. Exploratory surgery and subsequent gastrotomy or enterotomy is the treatment of choice for GI foreign bodies. If surgery fails to reveal a foreign body, biopsy samples should be obtained from representative sections of the gastrointestinal tract. Number four PDS suture material works well to close gastrotomy or enterotomy sites.

Helicobacter mustelae, a Gram negative rod, colonizes nearly 100 percent of North American ferrets shortly after weaning, and may cause a progressive inflammatory response in the stomach lining over the lifetime of the ferret. The signs of H. mustelae associated GI disease can be difficult to detect with some ferret's showing varying degrees of diarrhea and inappetence.. As the disease progresses and gastric ulceration develops, the ferret will start to pass dark, tarry stools (melena) indicative of upper gastrointestinal bleeding, as well as show signs of abdominal discomfort; grinding of the teeth and increased salivation. The treatment regimen for H. mustelae infections usually consists of "triple therapy" includes antibiotics from two different classes; amoxicillin (20 mg/kg PO q8hr) and metronidazole (20 mg/kg q8hr), as well as a H2 blocker; famotidine (pepcid, Merck 0.25-0.5mg/kg PO, IV q 24h), or proton pump inhibitor; omeprazole (4mg/kg PO q24h). An alternative regimen is bismuth (24 mg/kg q8hr) and amoxicillin plus clarithromycin (50mg/kg q24h or divided q12h) and bismuth subsalicylate (pepto bismol, 17mg/kg q12h). With all treatment regimens continue treatment for 2 to 4 weeks.

Coronavirus

Ferret systemic coronavirus-associated (FRSCV) disease

First recognized in Spain in 2004, FRSCV is an emerging systemic disease usually affects young ferrets < 24 months, Common clinical signs include gastrointestinal signs such as diarrhea, weight loss, lethargy, anorexia and vomiting. Signs of CNS disease are also reported and include ataxia, posterior paresis, pain when moving, bruxism, anorexia or difficult swallowing or drinking.[7] Clinical pathology: many times see a neutrophilic leukocytosis, anemia, thrombocytopenia, and a polyclonal hypergammaglobulinemia on protein electrophoresis. Grossly, whitish nodules were found in numerous tissues, most frequently the mesenteric adipose tissue and lymph nodes, visceral peritoneum, liver, kidneys, spleen, and lungs. One ferret had a serous abdominal effusion. Microscopically, pyogranulomatous inflammation involved especially the visceral peritoneum, mesenteric adipose tissue, liver, lungs, kidneys, lymph nodes, spleen, pancreas, adrenal glands, and/or blood vessels. Immunohistochemically, all cases were positive for coronavirus antigen using monoclonal antibody. FIPV3-70, however, this antibody cross-reacts with all group 1 coronaviruses and will also detect FRECV (see below). The Diagnostic Center for Population and Animal Health at Michigan State University is offering PCR-based testing to detect ferret coronavirus infections.

Ferret enteric coronavirus (FRSCV)/epizootic catarrhal enteritis (ECE)

A gastrointestinal disease that has been affecting the domestic ferret since 1993, when it was first identified in several ferret shelters in the United States and Canada. Research at Purdue University by Dr. Matti Kuipel and colleagues has definitively identified a coronavirus as the causative agent in this disease. Histopathologic lesions seen with ECE include intestinal villar atrophy, fusion and blunting, often with concurrent lymphoplasmacytic enteritis. Varying degrees of hepatic lipidosis have also been reported. The disease is extremely contagious, and can be spread by fomites. Treatment involves fluid therapy and supportive care.

Inflammatory bowel disease

The inflammation is primarily lymphoplasmacytic in ferrets, especially in the stomach, but about 50% of cases may also have a lesser eosinophilic infiltrate as part of the intestinal inflammation. A chronic or intermittent diarrhea is the hallmark of IBD. Stools may vary in quality from green or mucousy, to melena, to loose “birdseed” stools, to watery. Vomiting may or may not be seen and ferrets may show intermittent teeth grinding indicative of abdominal discomfort. Many ferrets show somewhat subtle signs of inactivity, periodic diarrhea and weight loss. Definitive diagnosis is based on histopathology of surgical biopsies. Treatment is aimed at eliminating any underlying contributing factors such as Helicobacter or food allergies and suppressing the inflammatory response. Any cases where biopsies confirm bacteria morphologically consistent with Helicobacter or where gastritis and little or no enteritis is found should be treated for Helicobacter. Food allergies can be addressed by changing to a hypoallergenic diet with a novel protein and carbohydrate source. This may be somewhat of a challenge in the highly carnivorous ferret. Hills z/d Feline® and IVD Duck and Green Pea Feline® have been tried with some success. Azathioprine and prednisolone have both been used to suppress the inflammatory response associated with IBD.

Endocrine diseases

Adrenal disease

Adrenal-associated endocrinopathy can be caused either by adrenal hyperplasia or neoplasia (most commonly cortical adenoma or adenocarcinoma). Adrenal disease in ferrets causes an array of clinical signs, with the most common being a bilaterally symmetrical alopecia, usually starting at or near the base of the tail and proceeding cranially along the body, sparing the head and extremities in most cases. Ferrets with adrenal disease may also show behavioral changes involving a return to sexual behaviors or aggression, and in some cases these behavioral changes may be the only clinical sign observed. Females may show an enlarged vulva, while males may have prostatic enlargement with secondary cystitis, prostatitis and dysuria. Less common signs seen in ferrets with adrenal disease include; polydipsia, polyuria, increased pruritus, odor associated with increased skin sebaceous secretions, or muscular atrophy of the hind limbs and abdominal musculature. Research suggests that castration plays a role in the pathogenesis of ferret hyperadrenocorticism and that the age of neutering was found to significantly correspond with the age of onset of ferret adrenal disease. It appears that it is the neutering itself that sets the stage for later development of hyperadrenocorticism versus the age at which these ferrets are neutered. To this end, gonadotrophic hormones appear to play a role in the pathogenesis of disease. Positive immunohistochemical staining has confirmed the presence pf LH receptors in the cortices of ferret adrenal glands and adrenal disease may be associated with expression of LH receptors on those adrenocortical cells responsible for producing sex steroids. The speculative hypothesis is that a lack of negative gonadal hormonal feedback on hypothalamic GnRH, as a result of neutering, results in persistently elevated gonadotropic LH and subsequent chronic LH receptor stimulation that may lead to adrenocortical hyperplasia and finally autonomous hypersecretion due to tumor transformation. This hypothesis is supported by studies in mice where LH receptors can function as tumor promoters as a consequence of persistent hormonal stimulation.

Diagnosis

The diagnosis of adrenal disease in ferrets is frequently straightforward and can often be made on history and clinical signs alone. Ultrasonography may identify an enlarged gland a (7.5 frequency with the near gain turned on high), and offers the benefit of determining if right, left or both adrenals are affected. Normal adrenal glands can vary greatly in length but should not vary much in thickness. The left adrenal gland on average measures from 5.4 to 9.8 mm in length and ranges 2.3 to 3.6 mm in thickness. The right adrenal gland size ranges from 5.8 to 10.5 mm in length and 2.2 to 3.3 mm in width. Abnormalities can include increased widths of more than 3.9mm, a rounded appearance, asymmetric poles, increased echogenicity, and mineralization.

For questionable cases, laboratory testing may be helpful. The University of Tennessee provides an assay that measures plasma concentrations of androstenedione, 17 α-hydroxyprogesterone and estradiol.

Treatment options

Surgery. The most definitive treatment for adrenal disease in ferrets has been and remains surgical removal of the affected gland(s)

Leuprolide acetate (Lupron- TAP Pharmaceuticals) is a long-acting gonadotropin-releasing hormone analog that desensitizes GnRH receptors at the pituitary to downregulate the release of gonadotropins LH and FSH. Clinical trials using the 30-day depot Lupron therapy at 100 mcg per ferret has resulted in complete regression of clinical signs within one to four weeks of treatment. However, regression may take up to three months to occur and can vary in these hormonally "seasonal" animals.

Deslorelin acetate (Suprelorin, Peptech Animal Health) is a slow release GnRH implant that is pending approval for use in the United States. One study in ferrets with adrenal disease showed that deslorelin demonstrated promise as a treatment to temporarily eliminate clinical signs and decrease plasma steroid hormone concentrations associated with adrenal disease. In this study a single 4.7-mg implant of deslorelin acetate controlled clinical signs associated with adrenal disease for varying periods of time between 8 and 30 months

Insulinoma (Pancreatic B cell tumor)

On histopathologic examination beta cell carcinoma is most often found, sometimes in combination with beta cell adenoma or hyperplasia. The neoplastic pancreatic beta cells secrete excessive amounts of insulin. The resulting hyperinsulinemia inhibits hepatic gluconeogenesis and glycogenolysis and stimulates the uptake of glucose by peripheral tissues; resulting in hypoglycemia. The rate of development, magnitude, and duration of hypoglycemia are factors determining the severity of clinical signs that can be categorized as neuroglucopenic, adrenergic or a combination of both. The serum glucose concentration required for diagnosis of hypoglycemia in the ferret is a matter of some debate. However, most clinicians agree that a 4-hour fasting glucose concentration of less than 60 mg/dl (4 nmol/liter) is very suggestive of insulinoma.

Long term treatment options include dietary, medical and/or surgical management, and many ferrets require a combination of all three to successfully control the clinical signs of hypoglycemia associated with insulinoma. The choice of therapy depends on severity of clinical signs, the age of the ferret, concurrent disease, and the owner preference. In most cases of ferret insulinoma micrometastasis of tumor cells exist throughout the pancreas with discrete tumor nodules being more uncommon. Surgical therapy therefore most often involves partial pancreatectomy with the goal of reducing insulin producing tissue and returning the ferret to a clinically normal state. Owners need to realize that case studies have demonstrated that as many as 52% of ferrets remain hypoglycemic after surgery with reported disease free intervals ranging from 0 to 23.5 months. Medical therapy in most cases will effectively control clinical signs of hypoglycemia, but will not stop progression of insulinoma. Prednisone and diazoxide (Proglycem®, Baker Norton Pharmaceuticals, Inc. Miami, FL) are used singly or in combination depending on the severity of clinical signs. Prednisone exerts its effect by promoting hepatic gluconeogenesis, reducing cellular glucose uptake and utilization, and inhibiting insulin binding to insulin receptors. Doses for prednisone range from 0.5 to 2 mg/kg every 12 hours. Begin at the lowest dose and increase as needed, to control clinical signs and maintain appropriate blood glucose levels. If clinical signs are not controlled with prednisone alone, the benzotriadizine diuretic, diazoxide may be added to the regimen. Diazoxide works primarily by inhibiting insulin release from pancreatic beta cells, but also by stimulating the release of epinephrine it reduces cellular intake of glucose and promotes glycogenolysis and hepatic gluconeogenesis. An initial dose of 10 mg/kg divided two times daily is added to the prednisone therapy and can gradually be increased to a maximum of 60 mg/kg divided two times daily, if lower doses are not effective in controlling the hypoglycemia.Ferrets with insulinoma should be fed many small meals, containing high quality protein and moderate to high levels of fats, throughout the day.

Cardiac disease

Diseases affecting the heart of the domestic ferret include dilated and hypertrophic cardiomyopathy, acquired valvular disease, and myocarditis. The signs of cardiac disease in ferrets include inappetence, weight loss, lethargy, rear limb weakness, dyspnea, and abdominal distension. Cough, emesis, ascites and dyspnea and syncopal episodes are also common presenting signs for ferrets suffering form cardiovascular or respiratory disease. The heart of the ferret is more caudally placed than in the dog or cat and dictates auscultation between the 7^{th} and 8^{th} ribs, rather than at the level of the axilla. Normal heart rate is 180-250 bpm. A pronounced sinus arrhythmia is common. Be aware that scruffing the ferret will slow the normal heart dramatically. The principles of cardiac disease treatment in the ferret are similar to those in the canine or feline patient.

Urolithiasis

In the ferret urolithiasis may be characterized by single or multiple calculi found anywhere throughout the urinary tract. Magnesium ammonium phosphate (MAP) or struvite uroliths unassociated with concurrent urease positive microbial infections are most commonly reported, but cystine bladder calculi have been reported and the author has seen two cases of cystine urolithiasis in mature males. The incidence of urolithiasis has lessened as ferret-specific commercial diets have improved nutritionally and gained acceptance among ferret owners.

Aleutian disease

Caused by a parvovirus that usually manifests as a chronic latent infection in ferrets; causing clinical disease over a period of one to two years. While the parvovirus itself causes little or no harm to the ferret, the marked inflammatory response generated by the host, results in production of a large number of antigen-antibody complexes. These circulate in the body and with time cause systemic vasculitis, most notably in the glomerular capillaries. As the disease progresses, a marked membranous glomerulonephritis and tubular interstitial nephritis result in eventual renal failure and death. In addition, a marked lymphocytic-plasmacytic response interferes with bone marrow hematopoiesis, and local accumulation of lymphocytes, plasma cells and macrophages may result in multiple organ dysfunction and failure. In end-stage disease, the marked hypergammaglobulinemia and vasculitis may result in anemia, thrombocytopenia and altered platelet function with subsequent petechial hemorrhage and clotting abnormalities. A tentative diagnosis of Aleutian Disease (AD) may be based on a combination of history, clinical signs and hypergammaglobulinemia (>20% of the

total protein showing a monoclonal gammopathy. Diagnosis of Aleutian Disease is confirmed antemortem with a positive serum titer coupled with hypergammaglobulinemia or lymphoplasmacytic inflammation in tissue biopsy samples. Serologic tests available for AD virus testing include the counterimmunoelectrophoresis (CEP or CIEP) test available from Blue Cross Animal Hospital (Burley ID, FerretADV.com) or Taconic (Animal Health Diagnostics, Taconic, Rockville, MD; www.taconic.com) or the enzyme-linked immunosorbent assay (ELISA) test for antibodies to the nonstructural proteins of the AD virus available from Avecon Diagnostics, Bath, PA, USA. Unfortunately the sensitivity and specificity of these two tests has been called into question. The University of Georgia DNA in situ Hybridization Laboratory tests serum for Aleutian Disease DNA using Polymerase Chain Reaction (PCR) and for AD antibodies using counterimmunoelectrophoresis (antibody titers are reported out to 1:16384, thus improving specificity).

Estrogen toxicity (Post-estrous anemia)

Female ferrets are polyestrous and seasonally induced ovulators and roughly one half of estrous females remain in estrus (during which time estrogen levels are high) if they are not bred or artificially stimulated to ovulate. Ferrets are very susceptible to estrogen-induced toxicity of hematopoietic tissue. Various manifestations of bone marrow suppression may occur including: pancytopenia, granulocytopenia, lymphopenia, normocytic, normochromic or hypochromic, macrocytic anemia or thrombocytopenia. Hemorrhage secondary to thrombocytopenia is a common cause of death in these cases; therefore spaying all females not intended for breeding is highly recommended. Diagnosis is made based on a history of being intact, signs of estrus such as a swollen vulva, and signs related to hematopoietic toxicity such as pale mucous membranes, subcutaneous and mucosal petechiae and ecchymoses, melena, fever and depression. Changes in complete blood count will also aid in diagnosis.

The goal of treatment is to bring the ferret out of estrus and provide supportive care until the bone marrow again becomes functional (this can take days to weeks).

Disseminated idiopathic myofaciitis (DIM)

A recently identified disease (2003) in the domestic ferret resulting in a severe inflammatory condition that affects primarily muscles and surrounding connective tissues. Although research is ongoing, the etiopathogenesis of this disease is still unknown, although an immune mediated inflammatory myopathy associated with vaccines/ vaccine adjuvant has been theorized but not proven. DIM generally affects ferrets younger than 18 months old with afflicted ferrets usually having multiple, concurrent symptoms the most common being a high fever (104-108º F), severe lethargy, paresis, dehydration, inappetence, enlarged lymph nodes, and abnormal stools ranging from green to mucoid to dark. Hyperesthesia is often noted on palpation of the lumbosacral region and hind legs. The duration of illness can last from days to weeks to even months, and most ferrets with DIM continue to decline until they die or are euthanized. On clinical pathology most ferrets with DIM exhibit a moderate to marked mature neutrophilia and a mild to moderate anemia. The WBC count can be as high as 50,000/uL. In general, there has been a lack of response to treatment and a high mortality rate associated with DIM, although a few confirmed cases have improved after receiving a combination therapy of cyclophosphamide, prednisolone and chloramphenicol.

Splenomegaly

A fairly common finding in ferrets, can be due to primary splenic disease, a distant systemic disorder or may be an incidental finding. The spleen can enlarge secondary to infectious agents, congestive states, lymphohematogenous disease, immunologic and inflammatory diseases, storage diseases and primary and secondary neoplasms. In many of these cases, the splenic enlargement is clinically insignificant. Splenic histopathology in these cases usually reveals extramedullary hematopoeisis or congestion or a combination of both. The cause of extramedullary hematopoeisis in the ferret is not clear. Extramedullary hematopoiesis is usually compensatory for myeloid insufficiency, but is commonly observed in ferrets without evidence of anemia or other blood dyscrasias.

Rule outs for splenomegaly include: lymphoma, primary splenic disease and incidental finding. Primary splenic tumors are rare but include hemangiosarcoma and hemangioma. Infection with Aleutian Disease virus has been associated with splenomegaly. It should be kept in mind that the presence of an enlarged spleen may have nothing to do with the clinical signs observed or the underlying disease found and may be an incidental finding.

Neoplastic diseases

Mast cell tumors or mastocytomas

Appear to affect both sexes equally, and present as flat to raised, well circumscribed, tan to erythematous, hairless plaques up to 1 cm in diameter. Mast cell tumors may be located anywhere on the body, though are most commonly found on the trunk, neck, and shoulders. Dermatologic signs often include pruritus, alopecia, hyperkeratosis, and the formation of a black, crusty exudates. Full excision is often curative.

Chordomas

The most common tumor of the musculoskeletal system in ferrets. They arise from the primitive notochord and are most often seen at the tip of the tail, though they have been uncommonly reported in the cervical and thoracic spine. The masses are usually lobulated, smooth, firm, well demarcated, and occasionally ulcerated. While they seldom metastasize, they are often quite invasive to the surrounding tissue. Amputation of the tail at the second intervertebral space cranial to the mass is necessary to ensure complete removal.

Apocrine gland neoplasms

Include cysts, adenomas, and carcinomas, and are most commonly found on the head, neck, prepuce, and vulva. Focal swelling and alopecia are the common presentation of all three types, while carcinomas can present with necrosis. Metastasis of carcinomas may occur to the local lymph nodes.

Osteomas

Firm, dense masses reported on the parietal bone, zygomatic arch, and occipital bone of the skull. Osteomas are generally radiodense and lack the typical sunburst appearance and variable lucency associated with osteosarcomas. While usually benign, they cause disfigurement, discomfort and potentially seizures or other central nervous system signs by exerting pressure on surrounding tissue.

Sebaceous epitheliomas and baso-squamo-sebaceous tumors

Are very similar clinically to basal cell tumors, and diagnosis of specific tumor type is based upon histopathology and cytology. These tumors are usually benign and surgery is curative.

Malignant lymphoma

A common diagnosis in pet ferrets. In a retrospective study of 574 ferrets with neoplastic disease, Li, et al found that 15.2% were hemolymphatic in origin and of these 78% were malignant lymphomas. Clinical signs of malignant lymphoma vary with the location of the disease as well as the age of the animal. Lymphoma can affect numerous tissues with the visceral and peripheral lymph nodes, spleen, liver, mediastinum, bone marrow, lung, intestine, and kidney being most commonly affected. Less frequently involved are the stomach, pancreas, nervous system and orbit. In addition, ferrets can develop a rare form of dermal cutaneous epitheliotropic lymphoma.

Clinical features of lymphomas in ferrets have been linked with animal age and tumor location, both of which are useful for evaluating diagnostic and therapeutic options. The most common form of lymphoma is a lymphocytic variant (where neoplastic cells are mature, well-differentiated lymphocytes) seen in ferrets older than three years of age. Lymph nodes are affected most commonly, resulting in peripheral lymphadenopathy. Visceral spread and subsequent organ failure may occur as the disease progresses. Clinical signs vary with which organ or systems are affected, however, most mature ferrets with lymphoma present with chronic, non-specific abnormalities including; intermittent inappetance, lethargy and weight loss. Other signs may include peripheral lymphadenopathy, posterior paresis, splenomegaly, chronic vomiting and diarrhea. A juvenile form of lymphoma, affecting ferrets 1-2 years of age, is typically an acute onset, multicentric lymphoblastic form of lymphoma, characterized by large immature lymphocytes that infiltrate the visceral organs early in the course of the disease. Splenomegaly, hepatomegaly and thymic enlargement may all occur, however peripheral lymphadenopathy is not a common finding. Clinical signs in young ferrets are often acute in nature and may mimic signs of a gastric foreign body: vomiting, dehydration, anorexia and wasting. Ferrets with mediastinal (thymic) lymphoma may cough and present with dyspnea. Ferrets with alimentary tract involvement may present with varying degrees of anorexia, vomiting, or diarrhea with or without melena. A third, relatively uncommon immunoblastic polymorphous form of lymphoma is seen in ferrets of any age and is characterized by lymphadenopathy and visceral organ involvement with short survival time after diagnosis.

Diagnosis of lymphoma involves biopsy of affected lymph nodes or visceral organs with direct visualization of neoplastic cells and evaluation of cellular morphology. While cytologic examination of lymph node, spleen, thoracic effusion, or bone marrow aspirates can provide a preliminary diagnosis, it is generally less informative than histologic preparations, because of disruption of tissue architecture. In addition, the large fat pads surrounding ferret peripheral lymph nodes make obtaining an adequate sample via fine needle aspiration difficult. Further parameters to consider when making a diagnostic and treatment plan for ferret lymphoma include; a complete blood count, a platelet count, a serum chemistry profile, a bone marrow aspirate, whole body radiographs (2 views) and abdominal ultrasonography.

Treatment choices for ferret lymphoma include surgery, chemotherapy, radiation, or combination therapy involving these modalities. Surgery may be considered as an alternative or an adjunct to chemotherapy in those ferrets affected with a solitary abdominal mass or cutaneous lesion. In ferrets with splenomegaly in which the spleen occupies more than 50% of the abdominal cavity, performing a splenectomy may augment treatment and patient comfort. Chemotherapy for ferret lymphoma involves single agent or combination drug therapy to suppress tumor growth. Numerous chemotherapy protocols have been used for the treatment of lymphoma in ferrets and the author recommends consulting with a veterinary oncologist, preferably one who has experience working with ferrets, for an opinion on the most up-to-date and practical protocols.

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