Gastrointestinal Foreign Bodies

Foreign body (FB) ingestion is particularly a problem in ferrets less than one year of age. Young ferrets enjoy chewing on and ingesting soft rubber such as latex or foam rubber, cork, and occasionally cloth material. After they reach one year of age their chewing behavior decreases greatly. In older ferrets obstruction or partial obstruction with trichobezoars becomes a relatively frequent problem. In ferrets with a gastric FB that is not causing an acute obstruction clinical signs are vague including intermittent anorexia, dark tarry stool and depression. Vomiting is an infrequent finding. Gradual weight loss may occur after weeks of illness.

Diagnosis of GI FB is made based on physical examination and radiography. Most ferrets have a relaxed abdomen and are easy to palpate. In most cases the clinician will be able to palpate the foreign material. Small trichobezoars may be difficult to palpate as they compress easily. Objects in the stomach are more difficult to palpate. Radiography may reveal a foreign object or gas pattern consistent with ileus secondary to intestinal obstruction. Contrast radiography may be performed if plain films are not diagnostic.

Treatment of GI FBs involves exploratory laparotomy and gastrotomy or enterotomy to remove the FB as an emergency procedure. The patient should be stabilized and rehydrated prior to surgery. A complete abdominal exploratory is performed and the entire GI tract evaluated. The techniques for gastrotomy and enterotomy in ferrets are analogous to those used in other species.

The gastrotomy incision is made in an avascular region of the stomach. Take a full thickness biopsy of the stomach wall using scissors to cut a slice off of one side of the primary incision and save it in the event that the ferret continues to have problems postoperatively. A two layer closure is recommended.

The diameter of the small intestine of ferrets is quite narrow and there are reports of intestinal stricture following routine enterotomy in ferrets. It is recommended that the enterotomy be made on the antimesenteric border of the intestine in the aborad (smaller) portion as this is the healthier portion of bowel. To minimize the risk of postoperative stricture, the enterotomy is closed transversely, in effect widening rather than narrowing the lumen at the enterotomy.

Adrenal Disease

At least 95% of generalized alopecia in neutered ferrets 2 years of age or older is caused by neoplasia or hyperplasia of the adrenal glands. Histologically there can be adrenal cortical hyperplasia, cortical adenoma or cortical adenocarcinoma. Metastasis is uncommon but has been reported.

Clinical signs associated with adrenal neoplasia consist primarily of bilaterally symmetrical pruritic alopecia, beginning at the hind quarters and progressing cranially along the body. Spayed female ferrets frequently present with vulvar enlargement with or without alopecia. Male ferrets with may present with prostatic enlargement or cysts with or without alopecia. Splenic enlargement and insulinomas are also common in ferrets with adrenal neoplasia.

The diagnosis is suspected on physical examination and history. Confirmation is frequently obtained using ultrasound evaluation of the adrenal glands. An adrenal steroid panel is available through the University of Tennessee to evaluate the circulating levels of some of the hormone precursors. Unfortunately, some adrenal masses do not produce these few hormones that are assayed in this steroid panel but these ferrets still have adrenal disease. Therefore, the panel is good if positive but a negative test does not rule out adrenal disease.

Surgery is considered the treatment of choice. A standard ventral midline celiotomy is performed. A complete exploratory celiotomy is performed because adrenal neoplasias frequently occur coincidentally with insulinoma and lymphoma. It is also important to evaluate the ovarian and uterine stumps and the mesentery for any evidence of ectopic or residual ovarian tissue.

The left adrenal gland is found deep within the sublumbar retroperitoneal fat just cranial and medial to the cranial
pole of the left kidney. Only the ventral surface of the gland can be visualized through the peritoneum. In some cases, this surface may appear grossly normal while the abnormal portion may be deeper and not readily visible. It is important to open the peritoneum and explore the entire gland using blunt dissection before declaring it normal. The right adrenal gland is located by elevating caudate lobe of the liver which touches the cranial pole of the right kidney. The hepatorenal ligament is incised and used to retract the liver ventrally allowing exposure of the adrenal. The adrenal gland is visualized on the dorsal aspect of the caudal vena cava attached to it. Because of its intimate association with the vena cava, removal of the right adrenal gland is more difficult.

The adrenal glands are evaluated for size, color, and shape - 2-4 mm x 4-6 mm and light-pink and homogenous. Lumps, hard spots, discolorations, cysts or gross enlargement are indications for removal. If both adrenal glands appear to be involved it is recommended that both be removed.

To remove the left gland, the adrenolumbar vein (phrenicoabdominal) over the left adrenal must be ligated on each side. Hemostatic clips are very for this. Once the vessels have been ligated, the adrenal gland is removed using sharp or blunt dissection. Cotton-tipped applicators are valuable in this dissection. Some tumors are large enough to envelope the kidney and invade the caudal vena cava, underscoring the value of adrenalectomy when the gland is small and not involving other organs.

Vascular clamps are vital in performing right adrenalectomy in ferrets. These clamps are designed occlude blood vessels atraumatically so the vessel wall is not damaged. The gland and associated cava are dissected circumferentially. When they are free from surrounding tissues 360°, the clamps are applied on the cava cranial and caudal to the adrenal. With the aid of magnifying loupes, a plane of dissection is developed between the adrenal and the vena cava. Dissection is continued until the adrenal is removed from the surface of the vena cava. Prior to releasing the clamp inspect the wall of the cava for small holes. Holes should be closed with a fine, absorbable suture such as 6-0 o 8-0 on a small needle. There are usually tiny holes in the wall that are not identifiable even with magnification. Hemostatic aides are helpful to control bleeding from these. Apply gentle pressure for approximately 5 minutes allowing the holes to seal. Irrigation is kept to a minimum to prevent clots from being dislodged. If an incision is created in the vena cava during dissection it is closed with a simple continuous pattern of 6-0 to 8-0 monofilament suture on an atraumatic needle.

Abdominal closure is routine. Postoperatively a dose of dexamethasone at 1 mg/kg body weight is administered (I usually give this intraoperatively as soon as the tumor is removed). In 24 hours the ferret is given 0.1 mg/kg prednisone orally once daily for 3 days followed by the same dose every other day for 3 treatments. Although postoperative steroids are not necessarily required it appears that many ferrets suffer less depression and have a more rapid return to their normal state when glucocorticoids are administered for a short period of time. Following bilateral adrenalectomy, ferrets often require glucocorticoid therapy for a longer period of time. Some require mineralocorticoid supplementation as well. These ferrets usually crump days to weeks postoperatively. They present clinically depressed, dehydrated, and often are nonresponsive. They typically respond to IV fluid therapy and steroid administration. Long term mineralocorticoid supplementation is recommended. Following adequate removal of the adrenal neoplasia, the swollen vulva will generally return to normal within 2 weeks and hair loss will begin to resolve in 1-4 months.

**INSULINOMAS**

Hypoglycemia in ferrets is usually caused by insulinoma (pancreatic beta cell tumors). The disease occurs with approximately the same degree of frequency as adrenal neoplasia and the two diseases commonly occur at the same time affecting both sexes 2 years of age or older. The tumor produces high levels of insulin driving glucose out of the circulation and into cells. Clinical signs generally consist of weakness and depression. These signs may be subtle and short-lived and may wax and wane. Ferrets salivate and paw at the mouth as if experiencing nausea. As the disease progresses the periods of weakness and lethargy become more pronounced and persistent. Some animals eventually develop seizures, coma and may die. Definitive diagnosis is made based on a fasting (4-6 hr) blood glucose of less than 70 mg/dl (normal is 90-100 mg/dl). Generally insulinomas are too small to detect with ultrasonography.

The recommended treatment for insulinoma is surgical excision. Patients with insulinoma should receive dextrose containing IV fluids during the procedure. As described for adrenal neoplasia a complete exploratory celiotomy is performed to evaluate for the presence of concurrent disease.

The pancreas has a right limb which is longer and larger than the left limb and is located within the mesoduodenum. At the caudal duodenal flexure, the right limb turns onto itself so that the entire right limb is right
of the root of the mesentery. The left limb is shorter and thicker and lies within the deep leaf of the greater omentum. The pancreas is V-shaped and the right and left limbs meet at the apex of the V which is called the body of the pancreas and lies at the pyloroduodenal junction. In most ferrets there is one pancreatic duct within the right and the left limbs which join to form the common pancreatic duct. The common pancreatic duct joins the common bile duct and empties into the duodenum as the major duodenal papilla 2.8 cm caudal to the cranial duodenal flexure. In a small percentage of ferrets an accessory pancreatic duct and minor duodenal papilla are present. The cranial and caudal pancreaticoduodenal arteries are the major blood supply to the right limb of the pancreas while the pancreatic branch of the splenic artery supplies the left limb. Analogous veins provide drainage.

To evaluate the pancreas, the free border of the greater omentum is pulled out of the abdomen and wrapped in saline moistened sponges. The proximal portion of the duodenum is exteriorized while the colon is retracted caudally. The left lobe of the pancreas is visualized in the deep leaf of the greater omentum. The right lobe is visualized within the mesoduodenum. The body of the pancreas is along the pyloroduodenal junction. By moving the duodenum toward midline the dorsal aspect of the right lobe can be seen. Moving the duodenum laterally allows visualization of the ventral surface of the pancreas. These manipulations will allow inspection of the lymph nodes as well.

Insulinomas range in size from microscopic, nonpalpable to 2 cm³, but can often be visualized within the pancreas as small firm masses (0.5-2 mm). These masses can be removed by blunt dissection. Hemorrhage is usually minimal and is frequently controlled using gentle digital pressure and a hemostatic agent. Small pancreatic ducts will generally seal and leakage of pancreatic enzymes in small amounts may not be associated with pancreatitis because enzyme activation has not occurred. Pancreatitis from rough tissue handling is uncommon.

The presence of multiple masses may be an indication for partial pancreatectomy and it has also been recommended that if no masses are palpable the left limb should be removed and submitted for histologic examination because sometimes these tumors are microscopic and diffusely disseminated within the pancreas. There are two methods for performing partial pancreatectomy - dissection and ligation of ductules and vessels, or suture fracture technique. The suture fracture technique requires less time but is associated with more inflammation. The area of the lesion and distal to it are isolated being careful not to disrupt the common pancreatic duct. The mesoduodenum or the deep leaf of the greater omentum is incised providing access to the right or left lobe of the pancreas, respectively. Using the dissection and ligation technique, the lobules are gently separated from adjacent tissue until the vessels and duct/ductules are exposed, ligated, then transected distal to the ligatures allowing removal of the tissue. With the suture fracture technique, following isolation, a ligature is passed around the portion of pancreas to be excised. As the suture is tightened, it crushes the parenchyma of the pancreas and ligates the vessels and ducts. The tissue distal to the ligature is excised. The defect in the mesentery or omentum is closed to prevent entrapment of viscera.

Care is taken to assure that the blood supply to other structures has not been compromised. When a portion of the right limb of the pancreas is removed, if the pancreaticoduodenal vessels are ligated, the blood supply to the proximal duodenum may be compromised. On the left side, ligation of the splenic vessels could occur, compromising blood flow to the spleen. Following partial pancreatectomy evaluate these organs before closing. Postoperatively the patient should be maintained on fluids containing dextrose at a maintenance rate for 24 hours. The patient is given a bland diet in small but frequent meals. Blood glucose is monitored every 12-24 hrs and may take 2-3 days to return to normal.

Surgical removal of insulinomas is generally considered a debulking procedure rather than a curative procedure as insulinomas have a high rate of recurrence and metastatic potential. Surgery provides definitive diagnosis and temporary relief of clinical signs. Some ferrets will not become euglycemic even after removal of one or more insulinomas. This appears to be due to metastatic and/or microscopic pancreatic lesions. Fasting blood glucose level should be evaluated two weeks postoperatively and then every 1-3 months to detect if insulinoma is recurring. Subsequent surgeries may be performed; however, in most cases, because surgery is not usually curative, the patient is managed with diet and medications following the first surgery.

Paraurethral or Prostatic Cysts

Male ferrets with adrenal neoplasia can develop prostatic enlargement, prostatitis, paraprostatic cysts, or paraurethral cysts. Treatment is aimed at surgical removal of the affected adrenal gland. Following removal of the adrenal the prostate rapidly decreases in size often within as little as 1 or 2 days. In some ferrets with
prostatic enlargement and paraprostatic cysts, the cystic structure may be as large as or larger than the urinary bladder. These cysts frequently contain a tenacious, green, often odoriferous material. This material is removed at the time of surgery; however, it is not necessary to marsupialize the cyst. Following removal of the adrenal neoplasia the cystic structure generally resolves rapidly.

Omentization of the cyst can be very helpful. A portion of the cyst wall is removed and submitted for culture and sensitivity, and histopathologic evaluation. The contents are removed attempting to minimize contamination. The omentum is pulled caudally and sutured into the lumen of the cyst. Removing the contents decompresses the cyst and allows urine to flow. The omentum brings in vascular support to the cyst to help clear up any infection that might be present. It is vital to make sure there is no defect in the urethra or urine will leak out the urethra, through the cyst and into the abdomen. If there is a urethral defect, an indwelling urinary catheter should be placed for 1-3 days to allow the urethra to heal.

**Splenomegaly**

Splenomegaly is relatively common in ferrets 2 years of age or older and may be the result of a variety of conditions. The spleen is easily palpated in ferrets and readily visualized on abdominal radiographs. Primary disease of the spleen is uncommon and its enlargement is usually secondary to some other problem. Splenomegaly in ferrets is generally a benign condition and routine removal of the spleen is not recommended. A spleen that increases rapidly in size over a very short period of time or one that is irregular in shape, painful or so large that it interferes with abdominal viscera function is cause for concern. Conditions which cause splenomegaly in ferrets include lymphoma, insulinoma, cardiomegaly, adrenal neoplasia, systemic mast cell tumors, Aleutian disease, eosinophilic gastritis, hemangiosarcoma, primary splenic neoplasia, hypersplenism and splenitis. The most common histologic diagnosis from Splenomegaly in ferrets is extramedullary hematopoiesis. These ferrets are actively producing red blood cells in their spleen and splenectomy can result in chronic anemia as this important site of red cell synthesis is removed. In cases where the spleen is excessively large, when the spleen is interfering with normal abdominal function, or if it is lumpy or irregular in shape, splenectomy or partial splenectomy should be performed. Preoperative biopsy of the spleen is recommended as partial splenectomy is preferred over complete removal if possible. Lymphoma, myelogenous leukemia, and nonvascular neoplasia such as leiomyosarcoma and fibrosarcoma can be diagnosed with splenic biopsy. Fine-needle aspiration is currently recommended for percutaneous biopsy of the spleen because it is simple, carries little risk, and provides excellent samples.

**Liver Biopsy**

The liver of ferrets has six lobes; left lateral, left medial, quadrate, right medial, right lateral, and caudate. Liver biopsy is indicated during most exploratory celiotomies. Diagnosis of hepatic lipidosis, lymphoma, metastatic insulinoma, and other hepatic diseases may be obtained using hepatic biopsy. The conformation of the liver lobes varies among individual ferrets. In some patients, a pointed portion of a liver lobe may be identified. A suture fracture technique as described for partial pancreatectomy is appropriate for liver biopsy when a protruding point of liver is identified. A ligature is looped around the protruding section of liver and tightened to cut through the liver parenchyma while ligating any vessels. Scissors are used to transect the tissue distal to the ligature leaving the ligature to control hemorrhage.

If all lobes have a rounded configuration, a transfixation suture fracture technique is used. This method is also used if a specific section of liver is desired for biopsy because of the presence of a lesion. The needle (atraumatic) is passed through the liver parenchyma and the suture is tied to cut through the liver on one side. The second throw on the suture is made to cut through the liver on the other side ligating the vessels supplying the liver distal to the ligature. The tissue is then transected distal to the ligature allowing excision of the biopsy specimen. Any residual hemorrhage is controlled with a hemostatic agent.