Foreign bodies can enter the body through any orifice and migrate remarkable distances. Clinical signs will vary with location of the foreign body, bacterial contamination, degree of migration, and inflammatory potential of the foreign material. The chemical composition of the foreign body is the main determinant of the severity of the inflammatory reaction. For example, oils and resins from wood can cause intense inflammation. Some plastics are slowly soluble, releasing irritating products. Metals can be oxidized and cause mild to moderate inflammation. In surgical patients, bulky, braided suture, starch, talc and gauze fragments can all incite reactions. Migrating foreign bodies removed from the soft tissues of dogs include plant awns, wood, glass, porcupine quills, needles, and toothpicks and have been removed from a variety of body locations, including deep muscle layers, thoracic cavity, abdominal cavity, urinary bladder, eye, and brain.

The body reacts to foreign material by dissolving it, extruding it, or walling it off. During the inflammatory reaction initiated by a foreign body, neutrophils secrete proteases in an effort to solubilize the material, and macrophages ingest particulate matter (Fig. 1). If the macrophage cannot digest the material, it persists at that site. Collagenases and other proteases released by the white blood cells prolong the inflammatory phase, and prevent the formation of granulation tissue essential to the repair phase of healing. Macrophages also produce substances that stimulate fibroblasts, leading to production of a collagenous capsule around the site of chronic inflammation. When a macrophage dies, the ingested foreign matter is released into the extracellular matrix, to be picked up by yet another macrophage, thus perpetuating the inflammation. Additional enzymes released from dead macrophages can necrose surrounding tissue, resulting in caseation that further stimulates the formation of a collagenous capsule. The presence of a sterile foreign body increases the susceptibility of the area to infection, and many foreign bodies carry bacteria that can flourish in the necrotic tissue produced by a severe inflammatory reaction. Histologically, foreign body reactions are characterized by pyogranulomatous inflammation with profuse neutrophil and macrophage populations.

A draining tract, which can be lined with granulation or fibrotic tissue, is created as the material produced by the inflammatory reaction follows the path of least resistance from the foreign body to the outside world. “Sinus” is formerly used to describe a tract that connects a source of inflammation to the surface of the body, while a “fistula” connects a body cavity or cavity organ to the surface or to another cavity; however, these terms are sometimes used interchangeably. When a foreign body migrates through the body, it can give rise to a succession of draining tracts. Differential diagnoses for a draining tract include foreign body, neoplasia, bone sequestrum, chronic inflammation, dermoid sinus, and perianal fistula.

Not all foreign bodies that end up in the deep tissues get there by simply penetrating the skin. Perhaps the most notorious example is the plant awn, which can enter through any body orifice as well as transdermally. In the United States, plants such as Hordeum, Stipa, and Setaria are sources of plant awns, also called foxtails. Barbs on the foxtails result in a one-way forward migration along fascial planes as the animal moves. Consequences of plant awn penetration vary with the location, but can include perforation of the tympanic membrane, conjunctivitis, granulomatous pleuritis, lumbar discospondylitis, and paralumbar abscesses. About 10% of affected dogs have plant awns at more than one anatomic site.

Foxtails are most commonly seen in hunting breeds of dogs. Dogs can readily inhale plant awns while open-mouth breathing as they run through the brush. The plant awn moves down the respiratory tract, penetrates the lower airway, and enters the lung. Migration continues through the lung parenchyma. During this time, the dog may experience a period of lethargy, anorexia, pyrexia, coughing, and/or fever. However, in many cases, plant migration through the respiratory system is not clinically apparent. The plant awn eventually exits the lung, and is directed by respiratory movements to the periphery of the diaphragm. From there, it is funneled into the intercostal muscles or the paraspinal muscles of the caudal thoracic or lumbar area. Another suggested mode of migration for foreign bodies that ultimately lodge in the lumbar area is penetration of the gastrointestinal tract at the caudal duodenal flexure or distal esophagus.

A common location for penetration of stick foreign bodies is the pharynx. In the acute phase, clinical signs may include dysphagia due to pain and reluctance to move the head. The stick typically penetrates the back of the pharynx and proceeds into the cervical region. The pharyngeal wound typically heals, and the dog eventually presents with draining tracts on the neck.

Once the foreign material becomes lodged, inflammation can begin in earnest. Secondary infection may occur within days of introducing the foreign body, or flare up acutely weeks to months later with no apparent inciting cause. Clinical signs may include periods of anorexia, lethargy, and fever that wax and wane for weeks to months. Dogs may improve when on antibiotics, and then become ill again when antibiotics are stopped. A foreign body may not be suspected until a firm or fluctuant, possibly painful swelling and/or draining tract develop. Marked abscessation can occur, with necrosis of surrounding muscle, septic pleuritis or peritonitis due to extension of infection into a body cavity, and/or generalized septicemia. Interestingly, bacteria cultured from migrating plant awns found in the thoracic or abdominal regions are typically those endogenous to the oral cavity or respiratory tract. It is believed that these organisms colonize the plant awn as it is passing through the airway.

Diagnostic workup for patients suspected to have a foreign body lodged in the deep soft tissues typically includes bloodwork, fine needle aspiration, and imaging. Depending on the intensity of the inflammation/infection, a complete blood count may show neutrophilic leukocytosis with or without a left shift and toxic changes. Serum chemistry panel is often unremarkable. Chronic inflammation may be reflected by hyperglobulinemia and anemia of chronic disease. Fine needle aspiration of the swollen area can reveal inflammatory cells and bacteria, and helps to rule-out neoplasia.

Survey radiographs can be diagnostic if the foreign material is radiopaque. Signs of a radiolucent foreign body may include soft tissue swelling, displacement of adjacent structures, minor changes in opacity inconsistent with normal anatomy, periosteal reaction of underlying bone, and gas in the soft tissues. In dogs and cats with migrating intrathoracic plant awns, findings on thoracic radiographs or computed tomography (CT) included focal pulmonary interstitial to alveolar opacities (most commonly in the caudal
lung lobes), pneumothorax, pleural effusion, pleural thickening, and thoracic lymphadenopathy. Cervical emphysema was a common finding on radiographs in dogs with acute penetration of a stick in the oropharynx or esophagus. Orthogonal radiographic views are required to localize the foreign matter. Radiopaque markers such as hypodermic needles can be aseptically inserted into the skin near the lesion to serve as radiographic landmarks, and left in place to help with localization of the foreign body during surgery.

To perform a sinogram or fistulogram, a catheter is inserted into the tract as far as possible. A balloon catheter helps prevent leakage of contrast; the tract opening can also be closed with a purse-string suture or manually held shut. Water-soluble, nonionic contrast is recommended, especially in cases where the tract might connect with a sensitive tissue such as pulmonary parenchyma. The contrast should be injected with just enough force to fill the tract, avoiding rupture that can spread contrast and potentially infection into adjacent tissues. Ideally, radiographs are taken just at the end of the injection when injection pressure is high. Two parallel radiolucent filling defects are characteristic of wood, while more irregularly shaped radiolucent filling defects could be foreign material, a fragment of tissue, exudate, blood clot, or simply inadequate filling. Thus, false positive and false negative results can occur.

Ultrasound can be used to trace draining tracts and to detect foreign bodies, which may appear as hyperechoic structures with an acoustic shadow. Ultrasonographic features of grass awns in the soft tissue of dogs include a spindle shape with 2 to 3 linear echogenic interfaces; acoustic shadowing was seen on transverse but not sagittal images. Inflammation surrounding the grass awn may create an anechoic halo that improves visualization. Methodical scanning of the entire swelling plus 2 to 3 cm of normal tissue is recommended when searching for a foreign body. Bone fragments, soft tissue mineralization, and air in the tract can all lead to false positive results. Intraoperative ultrasound can be useful to guide the surgeon’s dissection.

Magnetic resonance imaging (MRI) can be very informative in determining the extent of involved tissue. The inflammatory reaction creates increased signal intensity on MRI, and draining tracts can be traced. MRI is especially useful on foreign body reactions originating from very deep tissues. The images help the surgeon plan the surgical approach, and allow a three-dimensional assessment of the proximity of diseased tissue to vital structures such as the aorta and vena cava.

The definitive treatment for foreign body reactions is complete removal of the foreign material. Long periods of waiting to see if the draining tract or swelling will resolve on its own are usually unrewarding. While some patients show improvement on antibiotics and/or corticosteroids, clinical signs are likely to recur when the drugs are stopped. These drugs can suppress the suppurative reaction to the point that it makes it difficult to locate the foreign body with imaging or surgery. The ideal time for surgery is when the inflammatory reaction is relatively quiet, but there is still some drainage in the tract so the surgeon has a path to follow. Medications can be stopped prior to surgery to allow resumption of drainage in cases in which clinical signs of active inflammation are not severe or debilitating.

In preparation for surgery, the patient is widely clipped to allow room to follow long tracts. A tomcat catheter, red rubber tube, or groove director can be inserted into the tract to aid the dissection. Two techniques are used when a draining tract is present. In the first, the draining tract is slit open and followed to the source. The foreign material is then removed, and the tract is left open to heal on its own. However, if any fragments of foreign matter remain in or around the tract, the foreign body reaction will continue. The preferred approach is to make an elliptical incision around the tract opening, and dissect out the entire tract. While it is not as easy to follow branches off the main tract this way, it is more likely to successfully remove all foreign material, and surgical closure can be performed. A drain should be placed if complete resection is not assured. When a soft tissue swelling is present and draining tract is absent, the swelling can be incised directly or circumferentially excised.

In animals with large abscesses originating in the deep tissues, blood transfusions may be needed due to the high vascularity of the inflamed tissue. The surgeon should also be prepared to enter the thoracic or abdominal cavities to access all diseased tissue. Dissection should be continued until the foreign material is easily accessible; a foreign body that is grasped and pulled out with limited visualization may leave fragments behind that can incite further inflammation. Some foreign body reactions are secondary to miniscule fragments of foreign material, and it can be hit or miss as to whether the surgeon discovers this material. Furthermore, discovery and removal of foreign material in one area does not guarantee that additional foreign material does not remain elsewhere. Thus, unless the foreign body is relatively large and readily defined, it is prudent to try and remove as much affected tissue as possible.

Aerobic, anaerobic, and fungal cultures should be taken from the deep aspects of the inflammatory reaction. Cultures taken from the surface may contain contaminants that do not accurately reflect the population of organisms around the foreign body. Biopsy samples may be submitted when neoplasia has not been ruled out. After copious lavage of the surgery site, it can be closed primarily over drains. Closed suction drains (e.g. Jackson-Pratt) are easier to keep clean than Penrose drains, can be exited from a dorsal location when convenient, and provide a mechanism for monitoring both the quantity and quality (via serial cytology) of the drainage. Drains are removed when the drainage becomes serosanguineous and reaches an amount consistent with the presence of the drain itself. Postoperative radiographs can be taken to ensure complete removal of radiopaque foreign bodies.

The difficulty of achieving complete debridement of affected tissues may necessitate a prolonged course of antibiotics postoperatively. Empirical antimicrobials should target a broad spectrum of organisms, with definitive treatment based on culture and sensitivity results. Deep tissue foreign body abscesses often contain a mixed population of bacteria, which commonly include anaerobes. Specific organisms often reflect the site of entry of the foreign body. *Actinomyces* and *Nocardia* may be suspected when yellow “sulfur granules” are seen in the exudate, but the absence of these granules does not mean the absence of these organisms. *Actinomyces* is so commonly found with foreign bodies that it is thought that many cases of “Actinomycosis” are actually due to *Actinomyces* associated with miniscule fragments of foreign material that originated in the oropharynx.

Complete resolution of deep tissue foreign body reactions depends on successful removal of all foreign material and adequate debridement of infected tissue. Clients should be advised that it is not possible to know for sure if all foreign matter has been removed, and that the inflammatory reaction could return days, months, or even years latter. Draining tracts could recur in the original location or in other locations due to further migration of residual foreign material. Multiple procedures are needed in some.

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patients, and each subsequent surgery can be more difficult due to fibrosis, scarring, and the development of new tracts or swellings. Thus, because of the elusive nature of some foreign bodies, it is beneficial to obtain as much diagnostic information as possible about the extent of the inflammatory process before surgical exploration, and to be prepared for aggressive surgery that maximizes the chance that the foreign material will be removed.

References

Fig. 1. Persistent inflammation. Macrophages ingest foreign material, and if the material is not digestible, it is released into the environment when the macrophage dies. Additional macrophages are then recruited to the site and the cycle repeats. Cytokines and proteases produced by active macrophages also stimulate collagen deposition and the formation of a collagenous capsule. A vicious cycle is set-up with persistent inflammation.