Title: Lead toxicosis in falcons: method for lead retrieval

Running title: Lead retrieval in falcons

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Abstract:

Lead toxicity is the most common heavy metal toxicosis in free-living birds and one of the most important diseases of toxic origin in captive avian species. Falcons commonly ingest lead pellets or lead fragments concealed in the body of shot prey. The primary treatment of lead toxicosis consists of the retrieval of lead particles from the digestive tract and the secondary treatment consist of the use of chelating agents and support therapy. Lead retrieval from falcon undergoing lead toxicosis forms an integral part of the veterinary emergency and critical care practice and it should be undertaken immediately after metallic radiodense particles have been observed in the GiT at radiology examination. Lead pellets and lead fragments are retrieved using a combination of stomach lavage and using rigid or flexible endoscopes and long biopsy forceps.

Key words: Plumbism, toxicosis, lead, falcon, retrieval, Saudi Arabia
Introduction

Plumbism or lead toxicity is the most common heavy metal toxicosis in free-living birds including whooper swans (Cygnus cygnus), mute swans (Cygnus olor), common loons (Gavia immer), ducks and geese, pheasants, quails, partridge, waders and shore birds, and raptors and captive birds including sandhill cranes (Grus canadensis), houbara bustards (Chlamydotis undulata macqueenii), saker falcons (Falco cherrug), peregrine falcons (Falco peregrinus) and lanner falcons (Falco biarmicus), and pet birds.

Avian species can swallow lead intentionally, as in the case of waterfowl and game birds ingesting angler’s sinkers or spent shotgun pellets as grit, or accidentally as the case of raptors ingesting lead pellets or lead fragments concealed in the body of shot prey. The therapeutic management of lead toxicosis consist of the primary treatment involving the retrieval of lead pellets or lead fragments from the digestive tract and the secondary treatment concerning the use of chelating agents and support therapy.

An innovative endoscope-assisted gastric lavage technique to retrieve foreign bodies from the upper gastrointestinal tract (GIT) of psittacine birds was recently described. This technique is based primarily on the use of a 2.7 mm rigid endoscope placed within a sheath and inserted through the oro-pharynx or through a key-hole ingluviotomy to examine the crop, esophagus, proventriculus and ventriculus for the presence of foreign bodies. The use of a video camera
attached to the endoscope was recommended as the bird is suspended to an almost vertical position making difficult direct observation through the endoscope eye piece. A normal saline bag is attached to the port of the sheath to allow gentle infusion of the saline solution to dislodge any foreign material present.¹³

This paper describes the method used to retrieve lead pellets and lead fragments from the upper GIT of captive falcons presented at the Falcon Specialist Hospital and Research Institute of the Fahad bin Sultan Falcon Centre, Riyadh, Kingdom of Saudi Arabia.

Clinical Diagnosis of Lead Toxicosis

Lead toxicosis in captive falcons is diagnosed at this Hospital by using a combination of the anamnesis, the clinical symptoms, radiology examination and the measurement of lead level in whole blood.⁹

The most relevant clinical history information gathered is the periodic use of small mammals, such as jerboas (Jaculus jaculus) or jerbils (Gerbillus cheesmani), or birds, such as collared doves (Streptopelia decaocto) or domestic pigeons (Columba livia), shot by falconers to feed captive falcons. It is interesting to note that lead pellets have been observed at radiology in the ventriculus of falcons fed exclusively on pigeons purchased from the local bird markets. Dealers commonly acquire pigeons from local farms were shooting is a widespread practice. The possibility remains that one or more shotgun pellets are
left embedded in the muscle mass of some pigeons without causing any fatal injury. These pigeons commonly survive and are later trapped and sent to bird markets, where falconers unaware of this, purchase them to feed their falcons.

Typical clinical symptoms of clinical lead toxicosis in falcons includes amaurosis, ataxia, paresia of the wings and legs, hyperesthesia, and seizures. Subclinical lead toxicosis is, however, more difficult to diagnose as the falcons are usually presented with non-specific clinical symptoms including reduced to absence of appetite, shredding and flicking of food, delayed emptying of the crop, progressive weight loss, green colored urates and reduced performance during flight. Routine radiology examination involved the obtaining of radiographs in the ventro-dorsal and latero-lateral views.

Lead is the only heavy metal to which falcons are exposed in the Middle East. Thus the detection of radiodense metallic pellets or fragments within the GIT in falcons confirms the diagnosis of lead toxicosis. However, the absence of lead particles from the GIT does not rule out lead toxicosis as lead pellets and lead fragments are often cast out together with indigestible material such as fur and feathers. The most reliable method for the diagnosis of lead toxicosis is to measure the lead level in blood. At this Hospital blood lead levels are measured using an electrochemical system (LeadCare Blood Lead Testing System, ESA Inc, Chelmsford, MA, USA). This system contains an analytical unit, sensors and vials with pre-measured reagent. Fifty microliters of whole blood is mixed with the
reagent containing 1% hydrochloride acid solution. After mixing, the erythrocytes are lysed and the lead is released. Lead is then collected on the sensor and its concentration measured. The results are obtained within three min and are expressed in micrograms per deciliter (µg/dl).9

After confirming the diagnosis of lead toxicosis and in the absence of lead pellets or lead fragments in the upper GIT, treatment should proceed using mainly a chelating agent and support theraphy.9 The chelating agent of choice in the therapeutic management of lead toxicosis in falcons is calcium disodium ethylenediaminetetraacetate (Ca Na₂ EDTA) (25% Sodium Calcium Edetate, Animal Care Ltd, Dunnington, York, UK) at the recommended dose of 100mg/kg, undiluted, IM q12h. This recently suggested dose for Ca Na₂ EDTA has been used in captive falcons for 5 to 25 consecutive days without observing any evidence of muscle tissue damage or impairment of liver and kidney function.15

**Lead Retrieval**

Lead retrieval from falcon undergoing lead toxicosis forms an integral part of the veterinary emergency and critical care practice and it should be undertaken immediately after the diagnosis is made in order to prevent further absorption of the toxic agent.

General anesthesia is achieved using isoflurane (Isoflo, Abbott Laboratories, North Chicago, IL, USA), in oxygen delivered via a face mask prior
to radiological examination. If the presence of metallic pellets or fragments in the upper digestive tract is observed (Figs. 1, 2), the falcon is then prepared for the lead retrieval procedure. It is of the utmost importance to prepare in advance all the material and equipment needed (Figs. 3, 4). The falcon is removed from the face mask and an uncuffed 3.5 to 4 mm endotracheal tube, depending on the size of the falcon, is then placed and firmly secured around the head using gauze tape (Fig. 5). It is recommended to block the opening of the choana with a small ball of cotton wool to prevent stomach fluid entering the upper respiratory system (Fig. 6). The falcon is wrapped around its body using a kitchen tea towel. The towel can be secured around the shoulders and the base of the tail using masking tape. This will ease the handling procedure and avoid any mechanical damage that could occur to the feathers during the procedure. A stomach catheter, 4 mm in diameter and 350 mm in length with a blunt end, commonly used to feed neonate lambs (Lamb feeder, Arnolds Veterinary Products, Shrewsbury, UK) is lubricated using a water soluble jelly (KY Jelly, Johnson & Johnson Medical, Arlington, TX, USA) and gently introduced through the oropharynx into the crop (Fig. 7). The opening to the esophagus in falcons is found on the upper left corner of the crop. The endoscope is then manipulated through the esophagus and proventriculus until it is placed into the lumen of the ventriculus. This is easily identified by the appearance of the koilin layer commonly stained in falcons pale to dark green. An assistant lifts the falcon above the table in an angle of approximately 45º. A second assistant fills a 50 ml syringe with warm water (92°F to 95°F) before proceeding to connect it to the
catheter. The water is injected gently while the attending veterinarian maintains the stomach catheter in place. A large shallow square stainless steel tray (300 mm cm x 200 mm) is placed immediately below the anesthetized falcon to collect the water and stomach contents resulting from the lavage procedure. Very often lead pellets and lead fragments are expelled after using only 100 to 150 ml of water. Close and methodical examination of the stomach content retrieved is important in order to identify the particles of lead observed at radiology. Sometimes it is necessary to inject larger volumes of water, up to 250 ml, in order to dislodge lead particles together with food and casting material present in the ventriculus (Fig. 8). The placement of the stomach catheter and the lavage procedure should be carried out with extreme care if sharp fragments from long bones (e.g. femur) are observed at radiology.

Failure to dislodge lead pellets and lead fragments with the lavage procedure tends to occur in approximately 25 % of the cases. This is mainly attributed to lead pellets or large lead fragments becoming entrapped in folds of the proventriculus or ventriculus. In these cases, the use of endoscopy equipment is indicated to assist in the retrieval of those lead particles. In small falcons weighing 400 to 800 g, lead particles can be retrieved using a 0° 4 mm diameter rigid endoscope (arthroscope) with a 160 mm working length and a biopsy cup straight forceps with a 125 mm working length (Olympus Keymed Ltd, Essex, UK). In some cases, a longer biopsy forceps with a 340 mm working length has been used. After the stomach lavage procedure, the endoscope is
introduced through the oropharynx into the crop and then gently manipulated until it reaches the ventriculus. During this procedure the falcon is held on a snug towel on its chest. In most cases the lead is found at the bottom of the proventriculus or the ventriculus where they are easily observed after clearing out all the stomach contents following the lavage procedure. When lead particles are detected, the biopsy forceps is introduced carefully and manipulated parallel to the endoscope to grasp and retrieve the lead particle. In larger falcons (800 g to 1500g), a 6 mm diameter flexible endoscope (cystofiberscope) with a working length of 290 mm provided with a 2 mm working channel and an inlet port for the injection of water or air (Olympus Keymed Ltd, Essex, UK) is more appropriately used (Fig. 9). The lubricated endoscope is inserted through the oropharynx into the crop and gently manipulated into the ventriculus. If liquid stomach contents are still present hindering adequate visualization, small amounts (10-15 ml) of warm water can repeatedly be flushed in and then aspirated out using a 20 ml syringe attached to the port. Lead pellets or lead fragments are better observed with the proventriculus partially filled up with water (Fig. 10). Conversely, the injection of a small amount (25 to 30 ml) of air using a 20 ml syringe attached to the port can also aid the visualization of lead particles within the partially inflated ventriculus. After detecting the presence of the lead particle, a flexible biopsy forceps is inserted through the port of the working channel and directed towards the lead particle. This procedure is facilitated since the attending veterinarian has the ability to bend the distal end of the endoscope. The lead particle is firmly
grasped and the forceps together with the endoscope are gently pulled out simultaneously.

After retrieving all lead particles from the upper GIT, treatment of lead toxicosis should proceed using Ca Na$_2$ EDTA as suggested above and support therapy including gavage feeding, antibiotics, if necessary, and the parenteral administration of iron, and multivitamin preparations.$^9$

**Results and Discussion**

The method for lead retrieval described above has been successfully used in over 250 falcons for the past 6 years without observing any complication. The stomach lavage procedure has proved particularly useful not only to dislodge lead particles present in the ventriculus, but also to retrieve foreign bodies such as sand, feathers and fur and in more than one occasion, even grass. In the Middle East, falcons very often are fed outdoors on sand or grass lawns. It is not uncommon for fine sand or dry grass to stick to the food ingested leading to partial or total impaction of the ventriculus (Fig. 11).

The use of the flexible endoscope allowed lead retrieval in larger birds thus avoiding the need to perform a key-hole ingluviotomy to introduce a rigid endoscope in order to reach the ventriculus. Through the working channel, it is possible to insert other instruments, such as a basket type forceps, to aid in the retrieval of larger foreign bodies. The use of long flexible endoscopes can prove
useful in larger bird species, such as free-living large raptors (e.g. eagles), and waterfowl (e.g. swans) to retrieve lead pellets, or captive birds held in zoological collections (e.g. penguins) to retrieve foreign bodies ingested accidentally within their enclosures.

Public awareness programs using photographic pedagogic displays and brochures highlighting the toxic effect of lead in the general health of falcons have contributed to reduce the number of cases of lead toxicosis amongst outpatients seen at this Hospital every year.

References


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**Figure legends**

Fig 1. Ventrodorsal radiograph of a saker falcon (*Falco cherrug*) showing a shotgun lead pellet lodge in the ventriculus. The small radiodense longitudinal object seen on the left subhumeral area is a passive induced transponder (PIT).

Fig 2. Ventrodorsal radiograph of a saker falcon (*Falco cherrug*) showing a distended ventriculus containing lead fragments of different size entrapped with a large quantity of casting material including feathers and bones.

Fig 3. Materials, instruments and equipment used for stomach lavage in falcons to retrieve lead pellets from the upper GIT.

Fig 4. Endoscopy equipment and ancillary instruments used for lead retrieval in falcons.

Fig 5. Endotracheal tube placement in a saker falcon (*Falco cherrug*).

Fig 6. The placement of a cotton wool plug over the choana prevents leakage of stomach contents from reaching the nasal cavity and infraorbital sinus.

Fig 7. The lubricated stomach catheter is gently introduced into the crop and then manipulated until it reaches the ventriculus.
Fig 8. A large shallow stainless steel tray under the falcon allows collection, inspection of the stomach content and identification of lead pellets and lead fragments resulting from the lavage procedure.

Fig 9. The attending veterinarian is using a flexible endoscope and a flexible forceps to retrieve a lead pellet lodge in the ventriculus while an assistant holds the anesthetized falcon.

Fig 10. A lead pellet resting at the bottom of the ventriculus as seen through a rigid endoscope. Lead pellets or lead fragments are better observed with the proventriculus partially filled up with water.

Fig. 11.- A latero-lateral radiograph of a saker falcon (*Falco cherrug*). The falcon had been fed unfeathered quails and mutton on a sandy substrate. Fine sand may have adhered to the food ingested leading to total impaction of the ventriculus.