Diagnosis and Therapeutic Management of Trichomoniasis in Falcons in Saudi Arabia

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Abstract: A total of 7,085 different falcons were presented for examination at the Falcon Specialist Hospital and Research Institute of the Fahad bin Sultan Falcon Center, Riyadh, Kingdom of Saudi Arabia from September 1, 1998 to May 1, 2003. From this total, 393 (5.54%) individuals, including 346 (88.4%) saker falcons (Falco cherrug), 30 (7.63%) peregrine falcons (Falco peregrinus), 8 (2.03%) lanner falcons (Falco biarmicus), 5 (1.27%) gyr falcons (Falco rusticolus), and 4 (1.01%) gyr hybrid falcons were diagnosed with different clinical presentations of trichomoniasis infections. The disease appears to be directly linked to the traditional Arab falconry practice of training falcons using live domestic pigeons (Columba livia) and feeding falcons using freshly-killed domestic pigeons and doves (Streptopelia species). Some of these atypical presentations of trichomoniasis infections could represent a diagnostic challenge to the attending clinician. The need to establish a correct diagnosis of disorders affecting the upper respiratory and digestive systems in captive falcons cannot be over emphasized. Disorders to include in the differential diagnosis of trichomoniasis include Pseudomonas aeruginosa stomatitis, candidiasis, capillariaisis and vitamin A deficiency. The primary therapeutic protocol for clinical trichomoniasis included the use of the antiprotozoal agent metronidazole at the dose rate of 100mg/kg PO q24h for three consecutive days. Additional therapeutic measures were required depending on the severity and the anatomical location of the infection.
Introduction

Trichomoniasis is a common and important parasitic disease amongst captive falcons in the Middle East.\textsuperscript{1-5} For instance in a previous report in the State of Bahrain, from a total of 5,360 different falcons examined over a period of six years, 1,675 (31.2%) falcons were found to be affected with clinical trichomoniasis.\textsuperscript{1} Trichomoniasis is produced by the flagellate protozoon \textit{Trichomonas gallinae}, a parasite commonly found in the upper digestive and respiratory tracts of domestic pigeons (\textit{Columba livia})\textsuperscript{6} and doves (\textit{Zanaidura} species and \textit{Streptopelia} species).\textsuperscript{7-9}

In the Middle East, clinical trichomoniasis in captive falcons appears to be directly linked to the traditional Arab falconry practice of training falcons using live domestic pigeons and feeding falcons using freshly-killed domestic pigeons\textsuperscript{1-3} and doves.\textsuperscript{1} Arab falconers commonly purchase domestic pigeons in bird markets or trap them around farms in order to train or feed the falcons under their charge. In a study conducted in the United Arab Emirates, 68% of the domestic pigeons offered for sale in two bird markets and 35% of the free-flying feral domestic pigeons trapped in the surroundings of a farm were found positive to the presence of \textit{T gallinae}.\textsuperscript{4} In some areas of the Middle East, the trapping or shooting of collared doves (\textit{Streptopelia decaocto}) to feed falcons is also a common and widespread practice.\textsuperscript{1}

Typically, clinical trichomoniasis in falcons is characterized by the presence of white-yellow membranous or nodular caseous growths mainly in the oropharynx and crop.\textsuperscript{1} However, trichomoniasis infections in other anatomical areas of the upper digestive and respiratory tracts such as the nasal cavities, infraorbital sinuses, esophagus, and
tracheobronchial syrinx may also occur.\textsuperscript{1,3} These atypical presentations of trichomoniasis infections could represent a diagnostic challenge to the attending clinician.

This paper describes the diagnosis and the therapeutic management of different clinical presentations of trichomoniasis infections in captive falcons classified under the anatomical site affected.
Materials and Methods

A total of 7,085 different falcons were presented for examination at the Falcon Specialist Hospital and Research Institute of the Fahad bin Sultan Falcon Center, Riyadh, Kingdom of Saudi Arabia from September 1, 1998 to May 1, 2003. Each falcon presented to the hospital was subjected to a thorough clinical examination. On observation of suspicious membranous or nodular lesions, mainly in the oro-pharynx and crop, samples were collected from the vicinity using saline solution impregnated microbiology swabs. Impregnated swabs were rotated over the surface of a warm (32°C to 35°C) microscopic slide to produce wet smears. Smears were examined at 100x and 400x under light microscopy. Selected individuals were anesthetised with isoflurane (Rhône-Poulenc Chemicals Ltd., Avonmouth, Bristol, UK) in oxygen via a facemask to undergo endoscopic examination of the upper digestive tract using a 0° 4mm rigid endoscope, while the trachea was examined using a 0° 2.7 mm rigid endoscope (Olympus Optical Co, Ltd., London, UK). In addition, radiographs were obtained from some falcons in the dorso-ventral and lateral positions.

The current therapeutic protocol followed at our Hospital for clinical trichomoniasis includes the use of the antiprotozoal agent metronidazole (Metronidazole, Generics Ltd, Potter Bar, Herts, UK) at the dose rate of 100mg/kg PO q24h for three consecutive days. Marbofloxacin (Vétoquinol) 15 mg/kg IM q24h was administered for 5 days as part of the post-surgical treatment when surgical debridement was required.
Results and Discussion

From the grand total of 7,085 falcons, 393 (5.54%) individuals, including 346 (88.4%) saker falcons (Falco cherrug), 30 (7.63%) peregrine falcons (Falco peregrinus), 8 (2.03%) lanner falcons (Falco biarmicus), 5 (1.27%) gyr falcons (Falco rusticolus), and 4 (1.01%) gyr hybrid falcons were diagnosed with different clinical presentations of trichomoniasis infections. Some of the affected falcons exhibited trichomoniasis infections in more than one anatomical site. Following is an account of the clinical and pathological signs, diagnosis and therapeutic management of the different presentations of clinical trichomoniasis.

Clinical Trichomoniasis Infections

Oropharynx

The oropharynx was the anatomical region where clinical trichomoniasis was more often diagnosed in captive falcons. The total number of trichomoniasis infections observed at the oropharynx was 248 (55.23%). Typical clinical signs observed in affected birds included reduced to total absence of appetite, slow eating, the shredding and flicking of the food, difficulty in swallowing, the presence of meat strands around the beak after eating, weight loss and foetid smell in the oropharynx. Caseous nodular trichomoniasis growths were commonly found at the base of the tongue, within the choana and the caudal area of the oropharynx (Fig 1). The diagnosis of clinical trichomoniasis in the oropharynx was relatively easy since it could be carried out by visual examination. Observing T gallinae in wet smears obtained from the surroundings of caseous masses confirmed the diagnosis. Three to five days after completing the antipROTOzoal treatment, affected birds were anesthetized with
isoflurane (Rhône-Poulenc) in oxygen and an endotracheal tube placed. Trichomoniasis growths were removed by careful blunt dissection and any resulting hemorrhage arrested using manual compression. The main challenge in the therapeutic management of trichomoniasis growths in this region was related to the cavities left behind after the removal of large nodular growths. This was particularly important when there were large growths in the choana and under the tongue. After the removal of growths, if the cavities were deep, falcons were not allowed to eat solid food since food strands could lodge into the cavity and decompose. In this event, birds were force-fed with 40-50 ml/kg q12h of a mixture of minced whole quail (40%), minced beef liver (40%), whole egg (18%) and a carbohydrate-electrolyte preparation (2%) (Spark-Electrovet, Vetafarm, Wagga Wagga, Australia) via a stomach tube. The cavity was irrigated on a daily basis with warm normal saline solution and disinfected using povidone-iodine (Betadine, Seton Healthcare Group plc, Oldham, UK) or chlorhexidine (Hibitane, Zeneca Ltd, Macclesfield, Cheshire, UK). The topical treatment and force-feeding was continued until there was no danger of food lodging into the cavity, which was sometimes extended for up to two weeks.

Crop

The crop was also an anatomical site where clinical trichomoniasis was commonly diagnosed in captive falcons. The total number of trichomoniasis infections observed at the crop was 121 (26.94%). Clinical signs included reduced to total absence of appetite, slow eating, the shredding and flicking of the food, difficulty in swallowing, exaggerated movement of the head and neck when passing food from the crop, intermittent regurgitation and weight loss. There were two main types of clinical trichomoniasis presentations in the
crop of affected falcons, the nodular and the membranous types. The nodular type was characterized by the presence of small to large nodular caseous growths measuring up to 70 x 50 mm. In general, a single caseous nodular growth was present (Fig 6), but multiple growths were also encountered. The membranous type was characterized by the presence of a plaque-like growth affecting sometimes the entire crop. Caseous nodular growths present in the crop were easily identified by palpation. Membranous growths, however, were more difficult to identify by palpation unless well developed. Endoscopy was a very useful tool for the diagnosis of membranous type trichomoniasis infections of the crop. Wet mount preparations obtained from the crop usually revealed large number of *T. gallinae* thus confirming the diagnosis. Antiprotozoal therapy was instituted as soon as the diagnosis was made. Force-feeding via a stomach tube was normally necessary for five to seven days. Extreme care was exercised when manipulating the stomach tube within the crop in order to avoid lacerating the crop wall and to pass the tube into the subcutaneous space. This may occur if the tube was pushed accidentally, with some degree of force, under the growth where the already weakened underlying tissue could be easily penetrated (Fig 7). Most of the time, trichomoniasis growths in the crop detached spontaneously and were either cast out or passed undigested. A gentle massage to the crop everyday usually facilitated the removal of growths from the crop. In some chronic cases, the growth affected the wall of the crop protruding into the subcutaneous space and, more rarely, through the skin. Corrective surgery was necessary in order to remove the growth and repair the skin and the wall of the crop using standard surgical techniques.
Clinical trichomoniasis of the esophagus has been previously described in captive falcons. The total number of trichomoniasis infections observed at the esophagus was 40 (16.12%). Typical clinical signs included reduced to total absence of appetite, constant movement of the head and neck as if passing food from the crop, intermittent regurgitation and progressive weight loss. Lateral and ventro-dorsal radiographs commonly revealed medium to large size radiodense growths located at the distal portion of the thoracic esophagus just before converging into the proventriculus (Fig 8). Endoscopic examination was also a very useful clinical diagnostic tool to confirm the nature and size of the caseous growth. Some growths caused severe esophageal stenosis. As in the crop, the two types of caseous growths, the nodular and the membranous types, occurred in the esophagus. Wet-mount preparations usually revealed large numbers of T gallinae. Antiprotozoal therapy was carried out as soon as the diagnosis was made and the bird was started on a force-feeding regimen. As in the crop, extreme care was exercised when force-feeding using a stomach tube. Caseous growths, in the shape of diffused plaques or small nodular masses, usually detached five to seven days after treatment. However, this should be confirmed through endoscopic examination before offering solid food to the falcon. Trichomoniasis infections of the esophagus are very difficult to detect and very often fatal if not diagnosed on time since the esophageal wall may be perforated and create a fistula into the coelomic cavity. Endoscopic examination of the esophagus and stomach should form an integral part of clinical diagnosis in falcons with a similar clinical history.
Nasal cavity

Clinical trichomoniasis was observed affecting the nasal cavities of captive falcons. The total number of trichomoniasis infections observed at the nasal cavities was 16 (3.56%). Related clinical signs included partial or complete blockage of one or both nares, fluttering of the skin immediately above the infraorbital sinus, thick mucoid discharge from the choana and dyspnea. This clinical presentation of trichomoniasis was not very often evident until the caseous mass was large enough as to bulge through the palate (Fig 2, Fig 3) or the growth was of a chronic nature as to create a fistula. Falcons affected with mild intranasal trichomoniasis in general did not lose the appetite and continued eating normally during the therapeutic management of the infection. Falcon affected with large caseous masses bulging through the palate, however, needed assisted or force-feeding since eating proved painful.

The diagnosis of intranasal trichomoniasis was based on the anamnesis and clinical signs. The presence of *T. gallinae* in wet smears obtained from the choana confirmed the diagnosis. Five or seven days after completing the antiprotozoal treatment, the main objective of the therapeutic management was the thorough removal of all caseous material. In many cases the growths were removed through the choanal opening using a blunt-end probe and flushing, through the nares, the nasal cavities with a 1% solution of marbofloxacin (Vétoquinol) or a 0.5% solution of chlorhexidine (Zeneca) in normal saline. Several sessions were normally required to remove all caseous material and associated mucous. Conversely, parallel incisions at the cranial aspect of the upper palate were made to assist in removing large caseous growths. The incisions were sutured using simple interrupted stitches with 5/0 monofilament nylon. The antibiotic therapy was extended for up to two weeks in severe cases.
Infraorbital sinus

Clinical trichomoniasis affecting the infraorbital sinuses has recently been described in captive saker falcons (*Falco cherrug*). The total number of trichomoniasis infections observed at the infraorbital sinus was 18 (4%). Clinical signs included unilateral supraorbital swelling associated with enophthalmos (Fig 4), unilateral ocular and nasal discharges, fluttering of the skin just below the eye, reduced to total absence of appetite and progressive weight loss. Infections affecting both infraorbital sinuses have not been observed to date. Affected birds were given an antiprotozoal treatment for three to five days, together with marbofloxacin (Vétoquinol) 15 mg/kg IM q24h for five to seven days. At the end of the first week of treatment, the birds were usually considered ready to undergo surgery. Anesthesia was carried out using isoflurane (Rhône-Poulenc) in oxygen and an endotracheal tube placed. The supraorbital area was prepared for surgery and an incision made above the inflammatory process. Very often, encapsulated hard or soft caseous masses were found within small to medium size cavities. All caseous material was removed with the aid of a small Volkmann's curette. The cavity was then flushed repeatedly with a 1% solution of Marbofloxacin (Vétoquinol) or 0.5% solution of chlorhexidine (Zeneca) in normal saline to ensure thorough removal of caseous material and associated mucous. A single cavity, located cranial to the eye, was commonly communicated to the rostral area of the infraorbital sinus. In some cases, there were several inflammatory processes distributed around the eye necessitating multiple incisions. During surgery, in such cases, it was noticed that the cavities were not interconnected and were, therefore, treated as single encapsulated abscesses. After surgery, the skin was then sutured with single interrupted stitches using 5/0 monofilament nylon. Repeated surgery proved necessary in
some cases to remove previously undetected caseous material. The antibiotic therapy was very often extended for up to two weeks.

Tracheobronchial syrinx

Clinical trichomoniasis in the tracheobronchial syrinx has been previously described in captive falcons. The total number of trichomoniasis infections observed at the tracheobronchial syrinx was 6 (1.33%). General clinical signs included reduced to total absence of appetite and progressive weight loss. Specific clinical signs included marked dyspnea and severe tracheobronchial wet rale. Endoscopic examination of the trachea commonly revealed unilateral or bilateral membranous caseous growths obstructing partially the tracheobronchial syrinx (Fig 5). Wet mount preparations of mucous obtained from the distal trachea commonly revealed large numbers of T gallinae thus confirming the diagnosis.

It is important to include aspergillosis in the differential diagnosis of tracheobronchial syrinx obstruction in falcons as this type of infection is also very common. Five to seven days after antiprotozoal therapy, the falcons were ready for surgery. The birds were anesthetized with isoflurane (Rhône-Poulenc) in oxygen utilizing a facemask. Then an air sac cannula was placed to maintain the anesthesia and the thoracic inlet prepared for surgery. Caseous growths were removed via a tracheotomy using well-established surgical techniques.

Therapeutic Notes

Resolution of trichomoniasis infections was satisfactory in most cases. However, there were four cases in which the infection and associated pathology proved fatal. The first case involved a peregrine falcon with an esophageal infection in which there was
extensive damage to the esophageal wall resulting in a fistula and related peritonitis. Also, in two chronic cases involving saker falcons, the falcons died when localized necrosis to the tracheobronchial syrinx resulted in the formation of fistula and related peritonitis. In addition, one saker falcon, affected with a large trichomoniasis growth in the cranial aspect of the crop, died after the technical staff accidentally passed a feeding tube into the subcutaneous space leaving there a large amount of food overnight leading to an acute septicemia.

In a previous report, metronidazole was administered to affected falcons at the dose rate of 50 mg/kg PO q24h. Currently, the authors prefer to use metronidazole at a higher dose, 100 mg/kg, as this appears to be more effective in most cases. Carnidazole (Spartrix, Harkers Ltd, Bury St. Edmunds, Suffolk, UK) at the dose rate of 10 to 25 mg/kg PO as a single dose or for two to three consecutive days is widely used by many practitioners in the treatment of clinical trichomoniasis. However, observations made by the authors in the Middle East suggest that the results obtained with carnidazole are in most cases inconsistent even when the dose rate and periodicity are increased. This is probably due to differences in the virulence or it may be the result of resistance developed by *T. gallinae* strains affecting falcons in the region. Similar observations have been made of the resistance of *T. gallinae* to nitro-imidazole compounds in racing pigeon and other birds of prey. The need to establish a correct diagnosis of disorders affecting the oropharynx and the crop in falcons cannot be over emphasized. Disorders to include in the differential diagnosis of trichomoniasis include *Pseudomonas aeruginosa* stomatitis, candidiasis, capillariosis and vitamin A deficiency.
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**Figure legends**

Fig. 1. Large caseous trichomoniasis growth (c) located at the caudal area of the oropharynx in a peregrine falcon (*Falco peregrinus*). After removing such large masses, falcons should be tube-fed for a minimum of a week. This precaution is necessary to ensure that food strands are not lodged and decomposed in the cavity left behind.

Fig. 2. Saker falcon (*Falco cherrug*) with a nodular trichomoniasis mass (m) in the nasal cavity. In this case, clinical diagnosis was relatively easy as the growth was large enough as to bulge through the hard palate.

Fig. 3. A relatively small (8 mm) nodular mass (n) within the cranial aspect of the nasal cavity in a saker falcon (*Falco cherrug*). In such cases, the diagnosis of intranasal trichomoniasis is more challenging since masses such as this do not bulge through the palate.

Fig. 4. Trichomoniasis infection in the infraorbital sinus of a saker falcon (*Falco cherrug*) causing pronounced enophthalmos due to the severity of the inflammatory process (p). Note the abundant related discharge from the nostril.

Fig. 5. Unilateral obstruction of the tracheobronchial syrinx in a peregrine falcon (*Falco peregrinus*) due to a trichomoniasis membranous growth.
Fig. 6. Radiograph of a saker falcon (*Falco cherrug*) showing a single large trichomoniasis nodular growth (g) attached to the wall of the crop. The ovoid mass measured 70 x 50 mm. The mass was removed through the mouth in a single piece 8 days after treatment.

Fig. 7. An endoscopic view of the caudal area of the crop of a saker falcon (*Falco cherrug*). Note the large caseous trichomoniasis mass (t) partially obstructing the passage to the thoracic esophagus. During force-feeding of such cases, careful manipulation of feeding tubes is necessary in order to reach the gizzard.

Fig. 8. Post-mortem examination of a peregrine falcon (*Falco peregrinus*) affected by severe trichomoniasis of the crop (c) and esophagus (o). Note the sparse granular caseous masses in the crop and the diphtheritic membranous caseous growths affecting the entire thoracic esophagus.