Pseudomonas aeruginosa Stomatitis as a Sequel to Trichomoniasis

Infection in Captive Saker Falcons (Falco cherrug)

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Abstract: Twelve adult female saker falcons developed reduced appetite, progressive weight loss, and unilateral or bilateral sinusitis. Visible abnormalities included nodular white/yellow caseous lesions on the oro-pharynx and tongue. One of the falcons had two caseous masses on either side of the tracheobronchial syrinx resulting in severe tracheal stenosis. These masses were surgically removed intratracheally. All twelve birds had a history of mild to moderate trichomoniasis infections three to four weeks prior to examination. Bacterial cultures yielded pure growths of *P. aeruginosa* in all cases. Antibiotic sensitivity tests demonstrated susceptibility primarily to piperacillin, amikacin, and tobramycin. Hematology analyses demonstrated elevated WBC (25 ± 7.5 x10⁹/l [n=12], normal range 3.8 – 11.5 x10⁹/l), with mild to moderate heterophilia (6.2 ± 1.2 x10⁹/l [n=12], normal range 2.6 – 5.8 x10⁹/l), the presence of mega thrombocytes and elevated fibrinogen (6.6 ± 1.3 g/l [n=12], normal range 1.7 – 4.7 g/l). A combination of piperacillin (100 mg/kg) and tobramycin (10 mg/kg) was administered IM BID for seven days. Oro-pharyngeal lesions were debrided and the oral cavity sprayed with a 1% povidone iodine mouthwash preparation. In birds with unilateral or bilateral sinusitis, a solution of 0.2 ml of a 5% chlorhexidine gluconate preparation diluted to 20 ml with sterile saline was used to flush the affected sinus BID for three to five days. Complete resolution of oro-pharyngeal infections was achieved within eight to 18 days of treatment. Trichomoniasis infections coupled with stress during the training and hunting seasons may have been predisposing factors for *P. aeruginosa* infection.

Key words: *Pseudomonas aeruginosa*, saker falcon, *Falco cherrug*, stomatitis, trichomoniasis
Introduction

*Pseudomonas aeruginosa* is a medium-sized (0.5 - 1.0 x 1.5 - 5.0 µm), Gram-negative, strictly aerobic, oxidative, catalase-positive, oxidase-positive, motile and rod-shaped bacterium with a worldwide distribution. This bacterium produces several protein exotoxins, an enterotoxin, which is responsible for gastroenteric disorders, such as diarrhea at the onset of infection, and various extracellular products that could play an important role in the pathogenicity. *P. aeruginosa* possesses pili, which allows adherence to epithelial cells. Moreover, some strains of *P. aeruginosa* have a capsule, which is antiphagocytic. In avian species, the bacterium is normally thought to be an opportunistic pathogen and very seldom is considered the primary source of infection. It has been suggested that predisposing factors such as injuries to mucosal membranes, general weakness produced by systematic diseases, immunosuppression and reduced normal flora could lead to infections with *P. aeruginosa*.

*P. aeruginosa* is commonly associated with upper respiratory tract infections in psittacine birds. Similarly, *Pseudomonas* species are very often isolated from the respiratory tract, including the trachea, lungs and air sacs of juvenile ostriches kept under wet conditions and low temperatures. Other infections associated with *Pseudomonas* species in psittacine birds include panophthalmitis, sinusitis with enophthalmia, ingluvitis, otitis media, purulent air sacculitis and pneumonia, and cellulitis. In birds of prey, *P. aeruginosa* has been isolated from the nasal mucosal membrane. In addition, *Pseudomonas* species have been found associated with bumblefoot infections in raptors. Some virulent strains of *P. aeruginosa* can produce septicemia and could lead to acute death. Treatment of infections produced by this bacterium can prove difficult, since some strains are resistant to the most common antibiotics used in veterinary practice.

Although *P. aeruginosa* has been implicated mainly with upper respiratory tract infections in different avian species, its involvement in other types of infections is seldom described. This report describes a series of unusual cases of stomatitis produced by *P. aeruginosa* as a sequel to trichomoniasis infections in captive saker falcons (*Falco cherrug*).
Case Reports

Birds

From December 1998 to May 1999, twelve adult (>1 year) female saker falcons were admitted for treatment to the Falcon Medical and Research Hospital of the newly created Fahad bin Sultan Falcon Center, Riyadh, Kingdom of Saudi Arabia. The birds were maintained in two different collections and were used in the sport of falconry.

Clinical and pathological findings

On examination, all falcons demonstrated similar clinical signs and pathological findings. Clinical signs included reduced appetite, progressive weight loss, and in four cases unilateral or bilateral sinusitis with subsequent supra-orbital inflammation. The pathological findings included the presence of small nodular white/yellow caseous lesions, ranging in size from 2 mm to 5 mm, distributed mainly across the caudal aspects of the palate and the oro-pharynx (Fig. 1). In two cases, similar lesions were also observed under the tongue and on the lateral sides of the oral cavity. In eight cases, the tongue displayed numerous nodular lesions distributed across the dorsal and lateral aspects, with these lesions varying in size from 0.5 mm to 5 mm (Fig. 2). In three of these cases, the tongue showed larger amorphous lesions (10 mm – 15 mm) consisting of superficial caseous membranes. In all eight falcons, the presence of nodular caseous lesions on the tongue resulted in a gross enlargement of this organ to the extent that the falcons could not close the beak. A thick transparent mucous-like secretion covered the surface of the palate, the tongue and oro-pharynx in all cases. In all anatomical sites, but mainly on the caudal palate, most lesions appeared initially as a small focal inflammatory process. These lesions gradually increased until the apex of the caseous mass was visible on the surface. One of the 12 birds displayed severe dyspnea in addition to the oro-pharyngeal caseous lesions. The falcon was immediately anesthetized using isoflurane (Isoflurane RM, Rhônne Mérieux Ltd, Harlow, Essex, UK) administered intermittently by mask and examined intra-tracheally using a 2.7 mm endoscope. On examination, two caseous masses (approximately 5 mm x 8 mm) were observed on either side of the tracheo-bronchial syrinx producing severe stenosis of the tracheal lumen. These lesions were removed intra-tracheally using a custom made curette fitted with a long fine-wire handle and with the aid of a 2.7 mm endoscope. Immediately after removal, the lesions were sent to the laboratory for microbiological analyses. All 12 birds presented for treatment had a history of mild to
moderate trichomoniasis infections of the oro-pharynx or the crop, three to four weeks prior to examination.

**Laboratory diagnostic analyses**

Microbiology swabs were collected from the tongue and oro-pharynx of all affected birds. Samples were inoculated in Sheep Blood agar, MacConkey agar, with salt and crystal violet added, and XLD agar. Plates were incubated within a microbiology incubator at 37°C in an aerobic environment for 24 hours. All plates were then examined and the bacterial colonies identified based on the morphologic, cultural and biochemical characteristics. Morphologic characteristics included the microscopic appearance of the bacteria in Gram stain preparations and motility in the Hanging Drop test. Cultural characteristics included colony appearance on the different culture media and lysis on Blood agar. Biochemical identification of the bacteria was carried out using the API 20E kit (bioMérieux, Lyon, France). Antibiotic sensitivity analyses were carried out using Antimicrobial Susceptibility Test Discs (Oxoid Ltd, Basingstoke, Hampshire, UK) including amikacin, amoxycillin, cephalexin, clindamycin, doxycycline hydrochloride, enrofloxacin, gentamicin, oxytetracycline, piperacillin, ampicillin, rifampicin and tobramycin. Results from the cultures were consistent in all cases yielding only and exclusively pure growths of *P. aeruginosa*. The antibiotic sensitivity tests revealed susceptibility to piperacillin, amikacin, and tobramycin. In only two cases was the bacterium sensitive to gentamicin.

Blood samples were also collected from each falcon for complete hematology analyses. A total volume of 0.5 ml of blood was obtained from a basilic (brachial) vein of each bird using 0.6 x 16 mm disposable needles and 2.5 ml disposable syringes. After collection, the samples were mixed immediately with the anti-coagulant agent ethylene diamine tetra-acetic acid (EDTA 1.5 mg/ml of blood) in commercially available storage tubes. Hemoglobin was estimated as oxyhemoglobin using a Cynox I Hemoglobinometer (Buffalo Medical Specialties MFG. Inc, FL, USA). The rest of the hematological measurements including red cell count (RBC), white cell count (WBC), hematocrit (Htc), fibrinogen (Fib), and differential count were carried out using manual methods described elsewhere¹⁹,²⁰. Compared to healthy birds²¹, affected individuals showed increased WBC (25 ± 7.5 x10⁹/l [n=12], normal range 3.8 – 11.5 x10⁹/l), with mild to moderate heterophilia (6.2 ± 1.2 x10⁹/l
[n=12], normal range 2.6 – 5.8 x10^9/l), the presence of mega thrombocytes and elevated fibrinogen (6.6 ± 1.3 g/l [n=12], normal range 1.7 – 4.7 g/l).

**Treatment protocol**

A synergistic combination of piperacillin (Pipril, Lederle Lab, Gosport, Hampshire, UK) (100 mg/kg) and tobramycin (Nebcin, Eli Lilly, Fegersheim, France) (10 mg/kg) was administered IM BID for seven days. Falcons had access to fresh drinking water at all times. All affected birds were manually restrained daily and oral lesions debrided using a small Volkmann’s curette and curved fine-tipped dissecting forceps. On the tongue however, broad-tipped dissecting forceps were used to apply compression on both sides of the organ. After all the visible lesions had been debrided, the whole oral cavity was sprayed with a 1% povidone iodine mouthwash preparation (Betadine, The Nile Co, for Pharm and Chem Ind, Cairo, Egypt). The oral cavity was also sprayed using the same preparation in the afternoons, one hour before food was offered to the falcons. In birds with unilateral or bilateral sinusitis, a solution prepared using 0.2 ml of a 5% chlorhexidine gluconate preparation (Hibitane, Zeneca Ltd, Macclesfield, Cheshire, UK) diluted to 20 ml with sterile saline was used to flush the affected sinus BID for three to five days. This procedure was carried out with the conscious falcon wrapped with a soft towel and held up side down by an assistant. A 20 ml disposable syringe with a modified luer-lock tip was then applied to the corresponding nare and the solution injected into the sinus while the mouth was kept open to ensure adequate draining of the fluid through the mouth. After completion of antibiotic therapy, the treatment consisted of removing any caseous lesions present and the continuing use of the povidone iodine preparation.

In nine cases, complete resolution of oro-pharyngeal infections was achieved within eight to 12 days. However, in three cases caseous lesions were still present 15 to 18 days after initiation of treatment. The appearance of persistent caseous lesions after antibiotic therapy was considered the result of the inability to fully remove the caseous material during the early stages of treatment. Complete resolution of supra-orbital inflammations was achieved in all affected birds after three to five days of treatment. Birds were kept under observation for 21 to 25 days, during which time the appetite improved and a significant weight increment occurred.
Discussion

To the knowledge of the author, this is the first report of stomatitis produced by P. aeruginosa in falcons. Traditionally, caseous lesions in the oro-pharynx of birds of prey have been associated with trichomoniasis infections\textsuperscript{22-25}, vitamin A deficiency\textsuperscript{23}, capillariasis\textsuperscript{23,24}, candidiasis\textsuperscript{23-25} and viral infections\textsuperscript{23-25}. It is interesting to note that one of the falcons displayed caseous lesion in the tracheo-bronchial syrinx in addition to the oro-pharyngeal lesions. Microbiology analyses of the caseous masses also revealed pure growths of P. aeruginosa. Partial obstruction of the tracheo-bronchial syrinx is a relatively common pathological finding in birds of prey and is normally due to fungal growths\textsuperscript{26} and, more rarely, to trichomoniasis infections\textsuperscript{22}. To the knowledge of the author, growths on the tracheo-bronchial syrinx due to specific or non-specific bacterial infections have not been described in birds of prey.

In the present study, the combination of piperacillin and tobramycin was selected for the parenteral treatment of stomatitis in all cases since both antibiotics are highly active against P. aeruginosa\textsuperscript{27}. Furthermore, piperacillin acts synergistically with aminoglycosides, resulting in a broader activity against the different strains of the bacterium (Sharma, Wernery, personal communication, 1999). Tobramycin was the aminoglycoside of choice, instead of amikacin or gentamicin, since tobramycin is the least nephrotoxic of all compounds from this group in falcons\textsuperscript{28}.

Trichomoniasis is a common disease amongst falcons in the Middle East\textsuperscript{22,29} produced by the protozoon Trichomonas gallinae, a micro-organism commonly found in the upper digestive and respiratory tracts of doves and pigeons\textsuperscript{30,31}. This disease is commonly linked to the practice of feeding falcons with live or freshly-killed domestic pigeons (Columba livia)\textsuperscript{22,29,30,31}. In the Middle East, falconers normally purchase domestic pigeons to feed falcons in bird markets or they trap them around farms, where they are kept free-flying and are provided with lofts in the form of traditional towers. In a recent study carried out in the United Arab Emirates, up to 68\% of the domestic pigeons offered for sale in two bird markets and 35\% of the free-flying domestic pigeons caught in the vicinity of a farm were found positive to the presence of T. gallinae\textsuperscript{31}.

In the present study, all 12 falcons were fed freshly-killed domestic pigeons at least five times a week. The pigeons were procured from local bird markets. All the falcons had clinical trichomoniasis infections three to four weeks prior to the stomatitis caused by P. aeruginosa. It is assumed that the pathological insult to the oro-pharyngeal mucosal membrane produced by the trichomoniasis
infections, coupled with the stress associated with the falconry practices of training and hunting, may have been predisposing factors for the invasion of *P. aeruginosa*. A similar observation has been made in the Middle East with houbara bustards (*Chlamydotis undulata*) and stone curlews (*Burhinus oedicnemus*) maintained in captivity for breeding programs. Individuals of these species have developed similar caseous lesions, as those described in this report, produced by *P. aeruginosa* after trichomoniasis infections (Wernery, personal communication, 1999). In these cases, it was also considered that the stomatitis produced by *P. aeruginosa* were secondary infections.

It is proposed that infections produced by *P. aeruginosa* should be included in the differential diagnosis of stomatitis and tracheo-bronchial syrinx stenosis in falcons.

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References


Figure legends.

**Figure 1.** Saker falcon (*Falco cherrug*) with stomatitis produced by *Pseudomonas aeruginosa*. Note the numerous caseous white/yellow lesions on the palate just beside the caudal choanal slit.

**Figure 2.** A different saker falcon showing similar caseous lesions on the tongue, palate and the lateral aspects of the oral cavity. Note the enlargement of the tongue and the increased size of the papillae on its surface due to the inflammatory process.