

SERRATOSPICULOSIS IN FALCONS FROM KUWAIT: INCIDENCE, PATHOGENICITY AND TREATMENT WITH MELARSOMINE AND IVERMECTIN

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Summary:

The aims of this study were to determine the incidence of the filarial avian nematode *Serratospiculum seurati* in falcons from Kuwait, report clinical signs and find an effective therapy. Naturally occurring *S. seurati* infestation was diagnosed in 149 (8.7 %) out of 1,706 captive falcons examined between May 2003 and April 2005, and 140 of these were treated with melarsomine at dosage of 0.25 mg/kg injected intramuscularly for two days, and ivermectin, injected once at the dose of 1 mg/kg, 10 days later. Infestation was reportedly symptomatic in 107 (71.8 %) and non-symptomatic in 42 (28.2 %) falcons. Signs reported more often were dyspnoea (58.8 %), reduced speed and strength in flight (56 %), weight loss (38.3 %), anorexia/poor appetite (22.4 %) and lethargy (16.8 %). After administration of melarsomine, signs disappeared within 1-10 days in symptomatic birds and improvement of flight performances was noted in non-symptomatic birds. Dead adult parasites were ejected in 22 cases. Embryonated eggs were not detected in coproscopic checks made 10 and 40 days after the end of therapy, in association with lasting clinical remission. The main conclusion is that *Serratospiculum seurati* is overall pathogenic for birds of prey in the Middle East and that melarsomine + ivermectin can be an effective protocol of therapy eliminating both clinical signs and parasites.

KEY WORDS : *Serratospiculum seurati*, falcon, pathogenicity, treatment, melarsomine, ivermectin, Kuwait.

Résumé : LA SERRATOSPICULOSE CHEZ LES FAUCONS AU KOWEIT : INCIDENCE, SYMPTOMATOLOGIE ET TRAITEMENT PAR L'ASSOCIATION MÉLARSOMINE ET IVERMECTINE

La présente étude avait pour objectifs de déterminer l'incidence de la serratospiculose à *Serratospiculum seurati* chez les faucons au Koweït, de décrire les signes cliniques et d'évaluer une thérapie. Du mois de mai 2003 au mois d'avril 2005, 149 faucons (8,7 %) sur 1706 ont été trouvés parasités et 140 ont reçu un traitement intramusculaire de mélarsomine à la posologie de 0.25 mg/kg pendant deux jours, suivi d'une injection d'une dose de 1 mg/kg d'ivermectine 10 jours après. L'infestation était symptomatique chez 107 (71,8 %) faucons et non symptomatique chez 42 (28,2 %). Les signes cliniques les plus communs étaient une difficulté respiratoire (58,8 %), une diminution de la capacité au vol (56 %), une perte de poids (38,3 %), un manque d'appétit (22,4 %) et une léthargie (16,8 %). Les signes cliniques ont disparu en un à 10 jours chez les oiseaux symptomatiques après le traitement à la mélarsomine; de plus, il a été observé une augmentation de la capacité au vol chez les faucons auparavant décrit comme non symptomatiques. 22 rejetèrent des parasites adultes morts. Il n'a plus été observé d'œufs de *S. seurati* dans les examens coproscopiques 10 et 40 jours après la fin du traitement, en association avec une guérison complète. Les résultats de cette étude indiquent que l'infection à *S. seurati* est pathogène chez les faucons de chasse et que l'association mélarsomine + ivermectine est un traitement efficace sur ces parasites.

MOTS CLÉS : *Serratospiculum seurati*, faucon, symptomatologie, traitement, mélarsomine, ivermectine, Koweït.

INTRODUCTION

Serratospiculum sp. are filarial nematode parasites [*Serratospiculum* Skrjabin, 1915, Dicheilonematinae Werh, 1835, Diplotrianiidae Anderson, 1958, Diplotriaenoidea (Anderson & Bain, 1976)] of falcons transmitted by the ingestion of infected insects (mainly beetles). In the Middle East, *Serratospiculum seurati* is the most common falcon parasite (Wernery *et al.*, 2004). When they are eaten by the final avian host, the larvae L3 penetrate in the wall of the proventriculus and migrate to the airsacs and lungs where they mature into adult filarial parasites (Wernery *et al.*, 2004). After copu-

lation females release embryonated eggs that are coughed up, swallowed and leave the body of the host via faeces. Larvae develop in insect intermediate hosts, such as grasshoppers, locusts and beetles, and raptors get infested when feeding on them (Bain & Vassiliades, 1969; Lacina & Birds, 2000). The faecal microscopic finding of embryonated eggs indicates the presence of adult nematodes (Lacina & Birds, 2000; Zucca, 2003). Serratospiculosis is regarded as non pathogenic by some authors (Zucca, 2003), while others report cases of disease (Ward & Fairchild, 1972; Ackerman *et al.*, 1992) and deaths (Bigland *et al.*, 1964; Kocan & Gordon, 1976) in birds of prey, associated with inflammatory reaction of the respiratory tract, including air sac necrosis and disseminated necrotic foci in liver, kidneys and other organs (Smith, 1993). However, the records are mainly handling with cases of *Serratospiculum amaculata* infes-

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tation in birds of prey in North America (Wehr, 1938; Smith, 1993) whereas there is a lack of information regarding *Serratospiculum seurati*, the species reported in falcons in the Middle East (Zucca, 2003).

As a matter of fact, the pathogenicity of the nematode is still poorly understood, because: i) the recorded clinic cases are few; ii) the parasite does not appear to be pathogenic in low numbers (Smith, 1993); iii) the poor performance by symptomatic falcons (Wernery *et al.*, 2004) is not strictly pathognomonic or limitable to a *Serratospiculum* etiology; iv) no specific and resolutive therapy has been demonstrate to be effective so far. As a consequence of the limited available data on this topic, the aims of this study were to report the incidence of *Serratospiculum seurati* in a large population of falcons from the Middle East, the clinical signs observed in infested birds and the response to melarso-mine (Immiticide®/Cymelarsan®, Merial), a filarial adulticide medicament which has never previously been used in birds with serratospiculosis.

MATERIALS AND METHODS

From early May 2003 to the end of April 2005, microscopic examinations for the presence of embryonated eggs of *Serratospiculum seurati* (Fig. 1) were made on fresh faeces obtained from 1,706 captive falcons examined at the International Veterinary Hospital (Kuwait). Information evaluated included signalment, date of consultation, duration of the disease, previous treatments, clinical signs, intensity of infestation (+ = low, ++ = moderate, +++ = high, ++++ = very high) and therapy outcomes.

Therapy was based on the filarial adulticide melarso-mine (Immiticide®/Cymelarsan®, Merial), which is successfully used for the elimination of adult stages of *Dirofilaria immitis* and *Dirofilaria repens* in dogs (Baneth *et al.*, 2002; Tarello, 2002, 2003), injected intramuscularly at the daily dose of 0,25 mg/kg for two consecutive days, and the larvicidal/ovicidal ivermectin (Ivomec®, Merial), injected intramuscularly once at the dose of 1 mg/kg, 10 days after the completion of melarso-mine therapy (Lacina & Bird, 2000; Lierz, 2001).

Clinical re-examinations and faecal tests were carried out in the day of the ivermectin injection (day 10) and one month later (day 40).

RESULTS

149 (8.7 %) falcons belonging to four species (123 *Falco cherrug*, 21 *Falco peregrinus*, three *Falco rusticolus* and two *Falco pelegrinoides*) were diagnosed with serratospiculosis. Most cases (n = 124; 83.2 %) were diagnosed between October and February. Pre-



Fig. 1. – Embryonated egg of *Serratospiculum seurati*, 50 x 25 µm (× 400).

vious treatments, followed by recurrences, were recorded in 13 cases as follows: levamisole (6), surgical removal (5) and ivermectin (2).

Clinical signs were present in 107 (71.8 %) falcons (Table I). The association of the sign “dyspnoea” with one or more general clinical signs was recorded in 54 (50.4 %) cases. Serratospiculosis was diagnosed in 42 (28.2 %) healthy falcons brought for stool check. The relationship between intensity of infestation and the presence of clinical signs is reported in Table II. A χ^2

Clinical sign	N	%
Dyspnoea	63	58.8
Reduced speed and strength in flight	60	56.0
Weight loss	41	38.3
Anorexia/poor appetite	24	22.4
Lethargy	18	16.8
Vomiting	5	4.7
Closed eyes	5	4.7
Pain	4	3.7
Tremors	3	2.8

Table I. – Numbers and percentage of birds out of 107 falcons from Kuwait showing clinical signs associated with *Serratospiculum* infestation

	Intensity of infestation (based on the number of eggs/ \times 100 microscopic field)			
	(+)	(++)	(+++)	(++++)
N. of falcons showing general clinical signs	13	32	24	38
N. of falcons showing dyspnoea	8	15	14	26
N. of falcons reportedly healthy	14	20	5	3

+ = 1-3 eggs, ++ = 4-6 eggs, +++ = 7-9 eggs, ++++ = more than 9 eggs.

Table II. – Relationship between intensity of infestation and presence of clinical signs in 149 falcons from Kuwait infested with *Serratospiculum seurati*.

analysis clearly indicates that the level of egg excretion is connected with the presence of symptoms.

140 falcons (104 symptomatics and 36 asymptomatics) were treated first with melarsomine and then with ivermectin 10 days later. During the week following the melarsomine therapy, improved speed and strength in flight, in the absence of side effects, were homogeneously noticed in the group of 36 reportedly asymptomatic falcons. In the day of the ivermectin injection (day 10), faecal checks resulted negative in all 36 birds. Clinical re-examination and faecal tests carried out one month later (day 40) confirmed lasting improvement of speed and strength in flight in association with negative results of faecal exams.

Therapy with melarsomine was associated with immediate reduction and disappearance of the sign “dyspnoea” and led to complete recovery of all clinical signs in 101 (97 %) out of 104 diseased falcons within 10 days, whereas two birds died during the treatment and one found no clinical cure for its symptoms. Dead adult parasites (n. 1 to 9) were vomited during the melarsomine course or immediately afterwards in 22 cases (Fig. 2). Microscopic faeces examination carried out 10 days after the completion of adulticide treatment resulted negative in 98 birds, including the one not clinically cured, and a sharply reduced number of *Serratospiculum* eggs, mostly not embryonated, was seen in three cases previously heavily infested. No side effects were observed after the ivermectin injection administered the same day. Clinical re-examinations and faecal tests carried out one month later in all 101 falcons thus treated confirmed lasting remission in association with negative results of faecal exams.

DISCUSSION

Infestation due to the filarial nematode *Serratospiculum seurati* was diagnosed in 149 (8.7 %) of captive falcons from Kuwait. The observation that 107

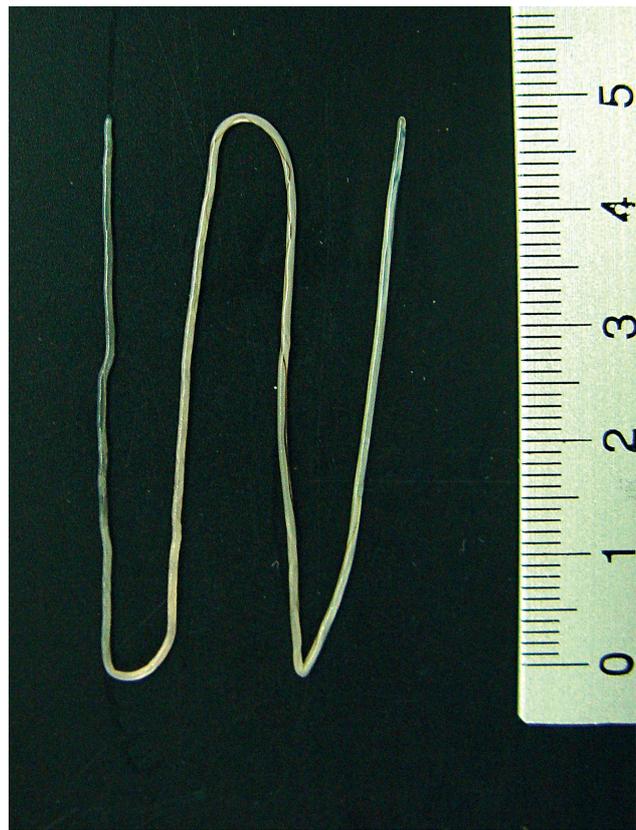


Fig. 2. – Dead adult female of *Serratospiculum seurati*, 0.8 \times 220 mm in size, vomited by a reported falcon during the melarsomine therapy.

(71.8 %) falcons were evidently symptomatic and 42 (28.2 %) were reportedly non-symptomatic but overall improved their flying performances when submitted to therapy, indicates that *S. seurati* is pathogenic for falcons.

The anti-filarial drug melarsomine proved fast and effective in eliminating clinical signs and *Serratospiculum* eggs in 101 (97 %) out of 104 manifestly ill falcons thus treated. Today, melarsomine is the only veterinary medication registered for use against adult stages of filarial nematodes and therefore was considered a valid candidate as therapeutic agent for serratospiculosis. Therapy was associated with immediate reduction and disappearance of the pathognomonic sign “dyspnoea”, the one reported more often (58.8 %), clearly associated with the localization of worms in the respiratory system. Within 10 days, all other recorded clinical signs (Table I) also disappeared, including “reduced speed and strength in flight” (56 %), weight loss (38.3 %), anorexia/poor appetite (22.4 %) and lethargy (16.8 %). This outcome is important because serratospiculosis is considered a parasitic disease of falcons difficult to treat successfully due to the location of worms within the air sacs membranes (Heidenreich, 1997). It may be argued that the death of adult nematodes was

not directly proved in this study. In fact, adult parasites were not searched nor surgically removed. However, the absence of embryonated eggs in faeces shortly after the specific filaricide therapy indirectly confirms the eradication/death of the adult nematodes. Detection of eggs (Fig. 1) is diagnostic for the presence of living adult parasites (Zucca, 2003).

Concomitant recovery from evocative signs, such as *i.e.* dyspnoea, and disappearance of eggs from faecal samples soon after administration of a specific therapy are indirectly diagnostic for the elimination of the adult stages. Similarly, detection of microfilariae in the blood is diagnostic for the presence of adult *Dirofilaria immitis* and *D. repens* and their disappearance after therapy with melarsomine is diagnostic for the eradication of adult worms (Baneth *et al.*, 2002; Tarello, 2002, 2003). Therapy of subcutaneous dirofilariasis proved also effective in lowering the number of microfilariae to 40 % (Baneth *et al.*, 2002), indicating that the disappearance of larval stages is the consequence of the adult death. In 22 cases in this study, one to nine dead adult nematodes (Fig. 2) were vomited during or shortly after the macrofilaricide therapy confirming the efficacy of treatment, whereas no recurrency of symptoms, shedding eggs or signs attributable to air sacs damage were ever noticed in checks carried out 10 and 40 days later. This is of notice since it has been frequently suggested that adult dead parasites may do more damage in the air sacs than live ones as they decay (Heidenreich, 1997). Such negative side effects were never noticed in the present study.

Durable improvement in flying performances and lasting disappearance of *S. seurati* eggs from faeces was noticed in 36 reportedly asymptomatic falcons submitted to melarsomine therapy. In these birds, as per the owner's report, comparison between flying performances before and after therapy was of great help in understanding the slightest variations of pathogenicity. In this study, the number of (reportedly) non-symptomatic birds showing a high-grade infestation was four-fold smaller (8 vs 34) than the number of non-symptomatic falcons carrying a low-grade infestation (Table II). Inversely, the numbers of symptomatic falcons showing general (n. 38) and respiratory signs (n. 26) in association with a very high parasite's burden were 3-fold more than the numbers of symptomatic falcons showing general (n. 13) and respiratory signs (n. 8) in association with a low-grade infestation (Table II). It indicates that the severity of symptoms is parasite burden-dependant, with high-grade infestations having three-four time more chances of developing evident symptomatology.

It has been claimed that filariid nematodes, such as *Serratospiculum seurati*, are difficult to treat successfully, because their location within the poorly-perfused air sac membranes or in the connective tissue of the

abdomen and thorax, makes them relatively immune to medical therapy (Heidenreich, 1997). A number of conventional anti-helminthic drugs, such as levamisole (Smith, 1993), fenbendazole, mebendazole (Beynon *et al.*, 1996), ivermectin (Lierz, 2001) and thiabendazole (Zucca, 2003) has been used so far in the therapy of serratospiculosis. However, there are no reports of specific therapeutic trials in infested raptors and, in this author experience, levamisole and ivermectin alone are not helpful in eradicating filarial agents (Tarello, 2003). Surgical removal of dead and moribund *Serratospiculum* worms is frequently recommended (Samour, 1996) as a consequence of the controversial results obtained using conventional anti-helminthic protocols.

Comparison between melarsomine and others drugs was not among the purposes of this study. Nonetheless, it is intriguing to note the striking degree of anti-parasitic action overall obtained in these raptors, including 13 birds relapsed after previous treatments with levamisole (n. 6), ivermectin (n. 2) and surgery (n. 5). In the day of the ivermectin injection, faecal checks proved negative for *Serratospiculum* ova in 135 out of 140 falcons treated, and one month later, 137 birds were still healthy and faecal checks were again negatives, indicating that melarsomine + ivermectin produced a durable elimination of adult and larval stages of the parasite. Similar response to macro- and microfilaricide treatments has been seen in the treatment of *Dirofilaria repens* infesting deep poorly-perfused subcutaneous tissues in dogs (Tarello, 2002).

REFERENCES

- ACKERMAN N., ISAZA R., GREINER E. & BERRY C.R. Pneumocoelom associated with *Serratospiculum amaculata* in a bald eagle. *College of Veterinary Medicine Journal* (University of Florida), 1992, 33, 351-355.
- ANDERSON R.C. & BAIN O. Keys to genera of the order Spirurida. Part 3. Diplostriaenoidea, Aproctoidea and Filarioidea, *in*: CIH keys to the nematodes parasites of vertebrates. Anderson R.C., Chabaud A.G. & Willmott S. (Eds), Farnham Royal, England, N. 3, 1976, 59-126.
- BAIN O. & VASSILIADES G. Evolutive cycle of Dicheilonematinae, *Serratospiculum tendo*, parasitic filaria of falcons. *Annales de Parasitologie humaine et comparée*, 1969, 44, 595-604.
- BANETH G., VOLANSKY Z., ANUG Y., FAVIA G., BAIN O., GOLDSTEIN R.E. & HARRIS S. *Dirofilaria repens* infection in a dog: diagnosis and treatment with melarsomine and doramectin. *Veterinary Parasitology*, 2002, 105, 173-178.
- BEYNON P.H., FORBES N.A. & HARCOURT-BROWN N.H. Formulary, *in*: Manual of Raptors, Pigeons and Waterfowl. British Small Animal Veterinary Association Ltd, Cheltenham, UK, 1996, 337-338.
- BIGLAND C.H., LIU S.K. & PERRY M.L. Five cases of *Serratospiculum amaculata* (Nematoda: Filarioidea) infection in

- prairie falcons (*Falco mexicanus*). *Avian Diseases*, 1964, 8, 412-419.
- HEIDENREICH M. Parasitic diseases, *in*: Birds of prey, Medicine and management. Blackwell Science, Oxford, UK, 1997, 131-148.
- KOCAN A.A. & GORDON L.R. Fatal air sac infection with *Serratospiculum amaculata* in a prairie falcon. *Journal of the American Veterinary Medical Association*, 1976, 169, 908.
- LACINA D. & BIRD D.M. Endoparasites of raptors – a review and an update, *in*: Raptor Biomedicine III, Lumeij J.T., Remple J.D., Redig P.T., Lierz M. & Cooper J.E. (Eds), Zoological Education Network, Inc., Lake Worth, Florida, 2000, 65-78.
- LIERZ M. Evaluation of the dosage of ivermectin in falcons. *The Veterinary Record*, 2001, 148, 596-600.
- SAMOUR J.H. Veterinary medicine, falcons and falconry in the Middle East. Proceedings of the Association of Avian Veterinarians annual meeting, Tampa, Florida, 1996, 233-239.
- SMITH S.A. Diagnosis and treatment of helminthes in birds of prey, *in*: Raptor Biomedicine. Redig P.T., Cooper J.E., Remple J.D., Hunter D.B. (Eds), Minneapolis, University of Minnesota Press, 1993, 21-27.
- TARELLO W. Cutaneous lesions in dogs with *Dirofilaria (Noctiella) repens* infestation and concurrent tick-borne transmitted diseases. *Veterinary Dermatology*, 2002, 13, 267-274.
- TARELLO W. Retrospective study on the presence and pathogenicity of *Dirofilaria repens* in five dogs and one cat from Aosta Valley. *Schweizer Archiv für Tierheilkunde*, 2003, 145, 465-469.
- WARD F.P. & FAIRCHILD D.G. Air sac parasites of the genus *Serratospiculum* in falcons. *Journal of Wildlife Diseases*, 1972, 8, 165-168.
- WEHR E.E. New genera and species of the nematode Superfamily Filarioidea. I. *Serratospiculum amaculata* n. sp. Proceedings of the Helminthological Society of Washington, 1938, 5, 59-60.
- WERNERY R., WERNERY U., KINNE J. & SAMOUR J. Colour Atlas of Falcon Medicine. Schlutersche Verlagsgesellschaft mBH & Co., Hannover, 2004, 102-105.
- ZUCCA P. Parasitic diseases, *in*: Avian Medicine. 2nd ed. Samour J. (ed.), Elsevier Science Limited, Edimburgh, 2003, 219-245.

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