Retrospective study of snake envenomation in 155 dogs from the Onderstepoort area of South Africa

R G Lobetti[a*] and K Joubert[a]

ABSTRACT

A retrospective study was undertaken to evaluate the incidence, signalment, haematological and biochemical changes, therapy, and outcome of dogs presented to the Outpatients section of the Onderstepoort Veterinary Academic Hospital for confirmed snake envenomation. Three hundred and seventy-six records of dogs presented for snake envenomation from 1998 to 2002 were reviewed and 155 were selected on the basis of there being a positively identified snake. The 2 most commonly encountered snake envenomations in dogs were puff-adders (*Bitis arietans*) and snouted cobras (*Naja annulifera annulifera*). The majority of cases (56 %) occurred in the autumn (March to May), with most being bitten by puff-adders. Dogs were 3 to 168 months old with a median of 36 months. No sex predilection was identified. Ten per cent of cases died because of the snake envenomation. Fifty-seven per cent and 43 % of snakebites were puff-adders and cobras, respectively. There was no difference in mortality between the 2 groups of snakes. Of the cobras 60 % were the snouted cobra, 14 % Mozambique spitting cobra, and 24 % rhinkals. Swelling in the area of the bite, usually the face and forequarters, was the primary clinical abnormality. Significant haematological findings were leukocytosis (median 17.3 $\times$ $10^9/\ell$; range 0.4–44), neutrophilia (median 13.6 $\times$ $10^9/\ell$; range 0.3–39.9), band neutrophilia (median 0.4 $\times$ $10^9/\ell$; range 0–5.32), and thrombocytopaenia (median 124 $\times$ $10^9/\ell$; range 3–555). Dogs envenomated by a puff-adder and Mozambique spitting cobra had a greater degree of thrombocytopaenia: median of 68 and 66, respectively, *versus* 243 for the cobra group. The most commonly used treatments were intravenous fluids, antibiotics and glucocorticoids. Thirty-eight dogs were treated with polyvalent antiserum: 9 for puff-adder envenomation and 29 for cobra envenomation. Only 2 of the dogs that received antisera died, both of them of cobra envenomation. The study concluded that snake envenomation in dogs is associated with high morbidity but moderate mortality rate and that the most significant haematological abnormality is thrombocytopaenia.

Key words: canine, Mozambique spitting cobra (*Naja mossambica*), puff-adder (*Bitis arietans*), rinkhals (*Haemachatus haemachatus*), snake bite, snouted cobra (*Naja annulifera annulifera*), South Africa.

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INTRODUCTION

Although snakebites are an important and common problem in southern Africa, especially in rural areas[11], there are very few reports in the veterinary literature. Reports that are available described bites by rattlesnakes[5], vipers[1,14], coral snakes[12], and tiger snakes[2], none of which occurs in southern Africa. The snouted cobra[4], boomslang[16] and the vine snake[13] have been described as single case reports in South Africa. There is thus a paucity of information regarding the epidemiology, clinical and laboratory changes, and outcome of snake envenomation in dogs in general, but especially in southern Africa. A recent review article has reported on the manifestation, pathogenesis, and therapy of snake envenomation in dogs[11] and the clinical signs, laboratory findings and outcome variables of viper snakes has been described[14].

Of the 175 snake species in southern Africa, envenomation by only a few will result in death[11]. Snake venom can be divided into 3 groups, namely cytotoxic (puff-adders and spitting cobras), neurotoxic (non-spitting cobras and mambas) and coagulopathic (boomslang and vine snake)[11,13,16]. The 3 different groups of venom are expected to result in different clinical manifestations.

The purpose of this study was to describe the signalment, clinical and laboratory changes, therapy, and morbidity and mortality rates in dogs with snake envenomation.

MATERIALS AND METHODS

This was a retrospective study where the records of 376 dogs presented for possible snake envenomation to the Onderstepoort Veterinary Academic Hospital (OVAH) over a 4-year period (1998–2002) were reviewed. Of these 376 records, 155 were selected as the snake envenomation had been confirmed, the snake positively identified, and complete data sets were present. Snakes were submitted to a herpetologist for identification (1998–2000).

The following data were generated from the records: patient signalment, snake type, date of envenomation, anatomic localisation of the bite, haematological and serum biochemistry, therapy, clinical outcome and duration of hospitalisation. Blood for haematology and serum biochemistry was collected prior to therapy.

The data were tabulated in a spreadsheet (Excel, Microsoft Corporation, Redmond, WA). Descriptive statistical analysis was performed with Sigma Stat (Jandel Corporation, San Rafael, CA).

RESULTS

The age of the dogs ranged from 3–168 months with a median of 36 months. Although there was no breed predilection, the majority of dogs were large breeds. Forty-six per cent of dogs were male and 54 % female.

Confirmed and non-confirmed snakebites were recorded in all months of the year (Figs 1, 2). The highest incidence (56 %) of envenomation occurred during the months of March to May. The puff-adder bites peaked during autumn while cobra bites tended to occur during the summer months, with a peak in January and a secondary peak in April. Almost no bites were recorded in winter (June–August) and a small increase noted in spring (September–November).

Fifty-seven per cent of the snakes were identified as puff-adders (*Bitis arietans*)

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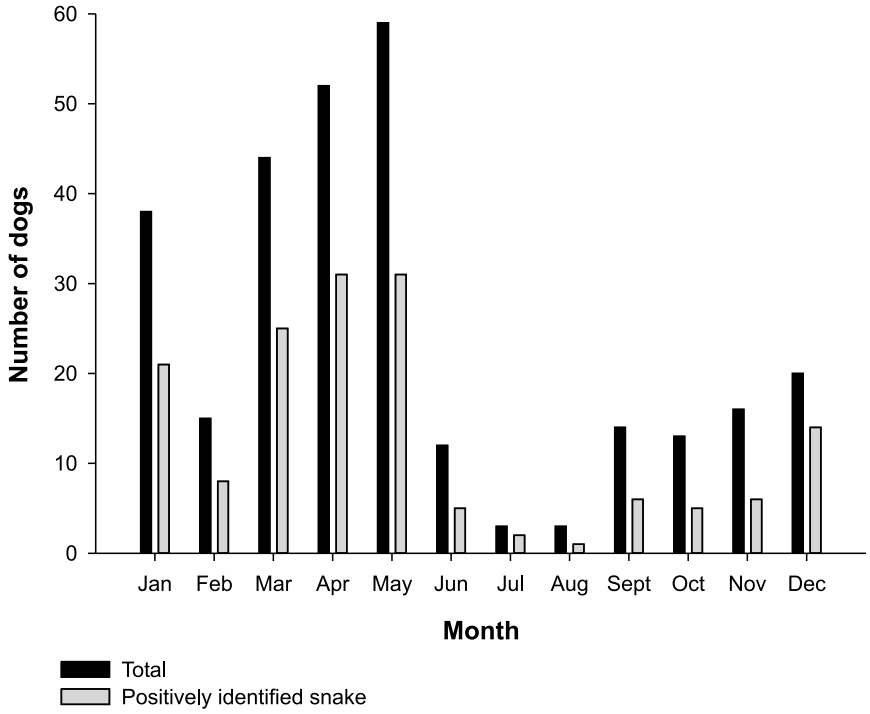

Fig.1: **The annual distribution of non-confirmed snake envenomation in 376 dogs *versus* confirmed envenomation in 155 dogs.**

and 43 % as cobras. Of the cobras, 60 % were the snouted cobra (*Naja annulifera annulifera*), 16 % Mozambique spitting cobra (*Naja mossambica*), and 24 % the rinkhals (*Haemachatus haemachatus*).

The most common clinical finding was swelling in the area of the bite, which occurred most commonly on the head (72 %) and the forequarters (16 %). In 12 % of cases bites occurred both on the head and the forequarters. The median hospitalisation time for dogs envenomated was 2 days for cobras and 3 days for adders, with an overall median for all dogs of 2.5 days.

Significant haematological findings were leukocytosis (median 17.3 × $10^9/\ell$; range 0.4–44), neutrophilia (median 13.6 × $10^9/\ell$; range 0.3–39.9), band neutrophilia (median 0.4 × $10^9/\ell$; range 0–5.32), and thrombocytopaenia (median 124 × $10^9/\ell$; range 3–555) (Fig. 3). Dogs envenomated by puff-adders and the Mozambique spitting cobra had a greater degree of thrombocytopaenia: median of 68 and 66, respectively, *versus* 243 for the cobra group (Fig. 4). There were no significant changes in the red cell parameters, with both the mean and median of the red cell count, haemoglobin, mean cell volume, and mean cell haemoglobin concentration being within normal reference range. There were no significant alterations in the serum biochemistry results. No other differences were detected between different snakes and haematological and serum chemistry results. Haemoconcentration occurred in 14 % of cases envenomated by puff-adders as well as cobras.

Affected dogs were most commonly treated with antibiotics and glucocorticoids. Intravenous fluids were used in 66 % of cases and hetastarch in 22 % of cases. Thirty-two per cent received analgesics, of which 38 % were non-steroidal anti-inflammatory drugs and 62 % opiods. Eighty-five per cent of dogs received antibiotics, of which the most commonly used were penicillin (80 %) and metronadizole (72 %). The latter 2 were most often given together. Forty-eight per cent of dogs were treated with cortisone and 7 % received either a blood or fresh frozen plasma transfusion. In total, 38 dogs were treated with polyvalent antiserum: 9 for puff-adder envenomation and 29 for cobra envenomation.

Of the 155 dogs in the study, 16 died from envenomation, which represents a mortality rate of 10 %. There was no difference in mortality rates between the 2 groups of snakes. A mortality rate of 5 % was found for dogs receiving antivenom, with no deaths in dogs bitten by puff-adders and 2 deaths in dogs bitten by the Mozambique spitting cobras *versus* 12 % in dogs not given antivenom.

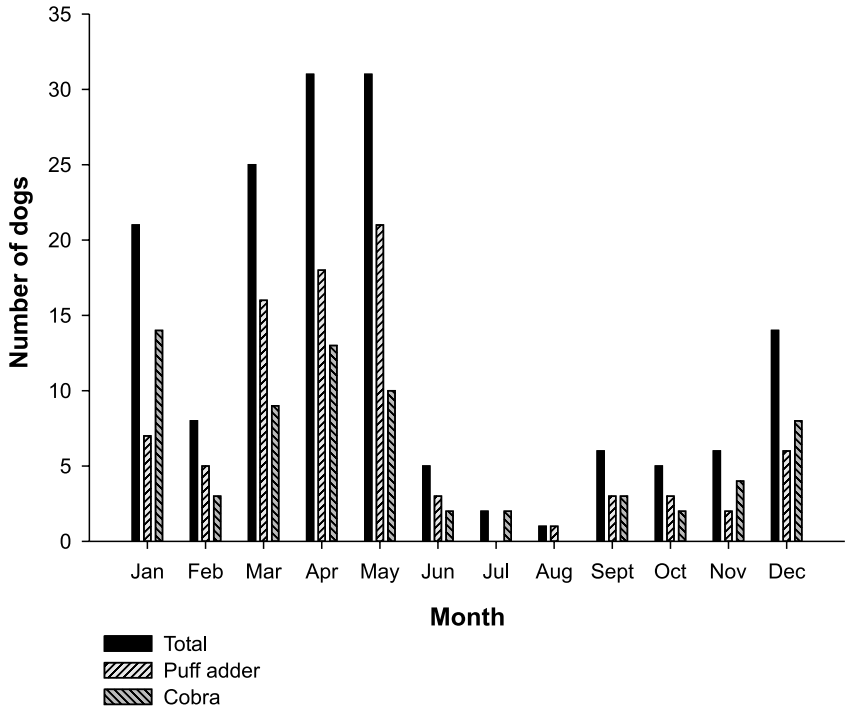

Fig. 2: **Annual distribution of confirmed snake envenomation in 155 dogs with a breakdown between puff-adders and cobras.**

DISCUSSION

The incidence of snakebites was highest in autumn (March to May) and mid-summer (December and January). In one study, most snakebites occurred in spring and summer (April to September) when the vipers were most active[1]. A study by Segev *et al.* showed that snakebites occurred from May to October in Israel[14]. In the United States, snake bites peak between May and September[5]. This is in agreement with data reported in this article, as it starts in late spring and continues to mid-autumn. In Australia, a country with similar climatic conditions to southern Africa, the highest incidence of snakebites occurred between December and January, with the season beginning in September and ending in March[2]. Temperatures above 20 °C during the changing of the seasons have been associated with an increased incidence of snake

bites[2]. The peak in early spring and late autumn may be related to snakes replenishing their fat stores before and after hibernation[4]. Puff-adders are known to breed in autumn, with males searching for females and fighting with other males (W D Haacke, Transvaal Museum, Pretoria, pers. comm., 2003). In late autumn and winter, most snakes are inactive and hibernating, with few bites reported in this period. Snakes mostly hunt in the late afternoon and evening, with most bites occurring during this period[14]. The low incidence of rinkhals bites is most probably due to the geographic location of the OVAH. The rinkhals is seldom if ever reported in the bushveld north of the Magaliesberg[8]. The Mozambique spitting cobra is seldom reported south of the Magaliesberg, with only few specimens having been found towards Johannesburg[8].

The dogs most commonly bitten were young, mature dogs of a medium to large breed, although snakebites occurred in very young (3 months of age) to very old (14 years old). The majority of the bites were on the head, neck or front limbs, suggesting a high incidence of confrontation between dogs and snakes. This is similar to what has been reported in the literature[1,2,5,14]. Not all snakebites result in envenomation. Up to 25 % of rattlesnakes bites are termed 'dry bites' with no envenomation occurring[5]. The low average number of days of hospitalisation was most probably affected by a number of dogs that were discharged within 24 hours of admission, as they showed no evidence of envenomation. It is generally recommended that humans be kept for observation for 12–24 hours following a snake bite in the event of delayed symptoms of envenomation[7].

Haematological changes suggest an acute inflammatory reaction characterised by leukocytosis with neutrophilia and a left shift. These findings are similar to what has been reported for the viper snake[14] and rattlesnakes[5]. Stress may be a contributing factor to leukocytosis and neutrophilia, but it is not usually accompanied by a left shift. Haemoconcentration was a common finding following viper snake[1,14] and rattlesnake[5] envenomation. In the present study, haemoconcentration only occurred in 14 % of dogs. The pathogenesis of haemoconcentration may involve splenic contraction[1,14]. A more prominent mechanism, however, could be fluid losses to third spaces due to the haemorrhagins, which produce vasculitis, and the resulting leaking of the capillaries leading to loss of fluids, proteins and cells at the bite site. Dehydration is an unlikely mechanism as

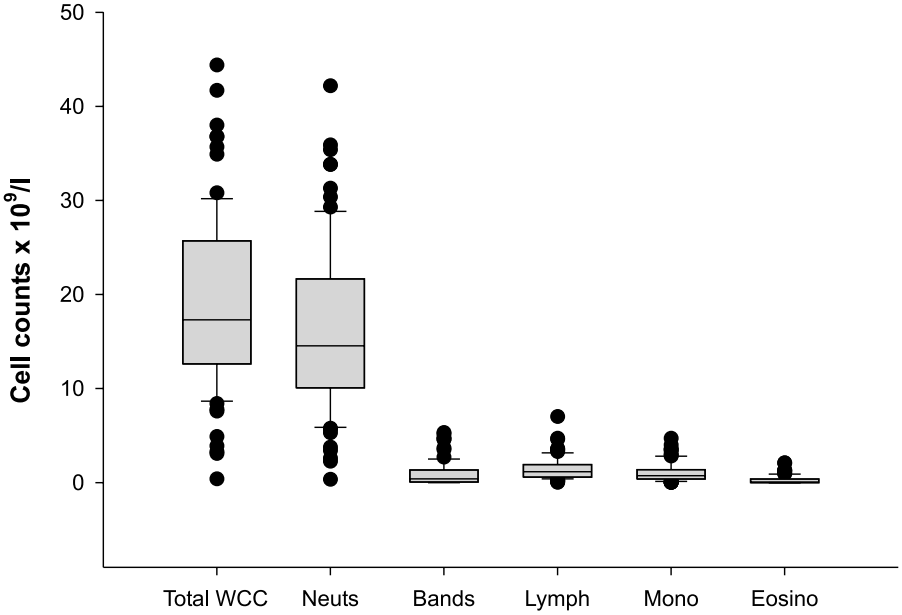

Fig. 3: **White cell count and differential white cell counts for snake envenomation in 155 dogs. Data shown as median** (horizontal line within box)**, 25th and 75th percentiles** (horizontal ends of boxes)**, and 10th and 90th percentiles** (T-bars)**. Black circles represent outliers. WCC = white cell count; Neuts = neutrophilia; Bands = band neutrophilia; Lymph = lymphocytes; Mono = monocytes; Eosino = eosinophiles.**

total serum proteins were low-normal and lower in most cases[1,5,14]. The haemoconcentration underlies the importance of resuscitation with fluids. Segev *et al.* concluded that with viper envenomation, haemoconcentration was strongly suggestive of an increase in mortality rate[14], but this is, however, not supported by the present study.

Thrombocytopaenia was a common finding in this study, with dogs envenomated by puff-adders and Mozambique spitting cobras having a greater degree of thrombocytopaenia (below normal reference range) than those envenomated by the cobra (low end of normal reference range). Both puff-adders and Mozambique spitting cobras are considered to be cytotoxic[11]. Puff-adder venom contains an irreversible platelet aggregation component[3]. Thrombocytopaenia has been reported in humans and dogs bitten by vipers[1,14] and rattlesnakes[5]. In viper envenomation, possible mechanisms leading to thrombocytopaenia may include vasculitis, the sequestration of platelets in inflamed tissue, the development of disseminated intravascular

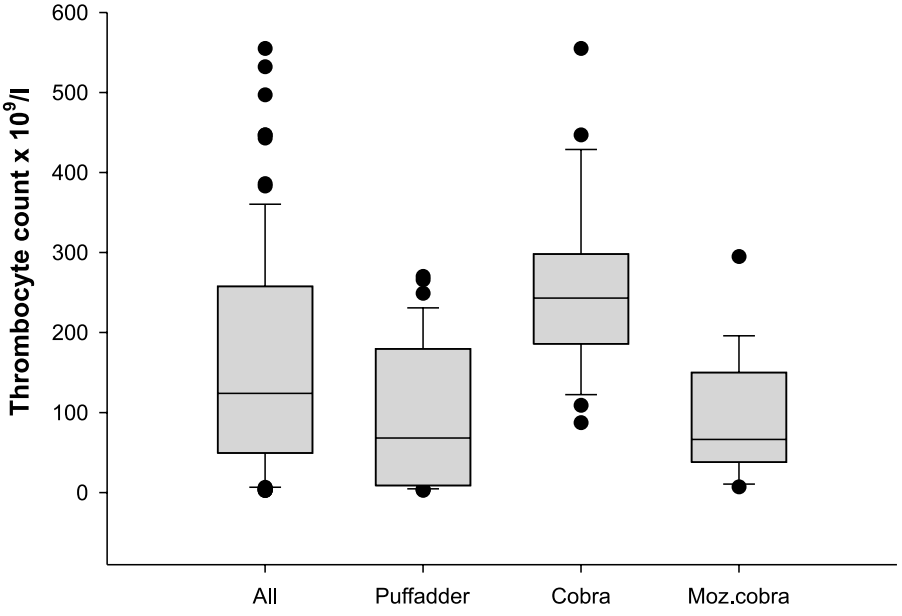

Fig. 4: **Thrombocyte counts for 155 dogs with snake envenomation, and separately for puff-adder, cobra, and Mozambique spitting cobra envenomation. Data shown as median** (horizontal line within box)**, 25th and 75th percentiles** (horizontal ends of boxes)**, and 10th and 90th percentiles** (T-bars)**. Black circles represent outliers.**

coagulation, and the presence of an anticoagulant factor in the venom[10,14]. In rattlesnake cytotoxic envenomation, thrombocytopaenia may result from factors within the venom causing aggregation, adherence of platelets to damaged endothelium, and *via* the release of inflammatory mediators[5,6]. Antivenom administration after rattlesnake envenomation has been shown to increase platelet counts[5]. In coral snake (elapid) envenomation, the mortality rate has been correlated with thrombocytopaenia[12]. The thrombocyte count was included in the original APACHE scoring system used to predict mortality rates of humans in intensive care units[9] and may indicate that thrombocytopaenia is related to the severity of injury.

The prophylactic use of antibiotics has been questioned, as the incidence of bacterial infections following snakes bites in humans is low[5]. This viewpoint has been supported in the recent review of the management of snakebites[11].

The overall mortality rate in this study was 10 %. A 3–4 %, 1 %, and 15 % mortality rate has been reported in viper snakes[1,14], rattlesnakes[5,] and tiger snakes[2], respectively. The higher mortality rate may be associated with differences in venom between puff-adders and cobras compared to viper snakes. The administration of antivenom in dogs bitten by vipers did not increase survival[14]. The mortality rate in dogs treated with antivenom after tiger snake envenomation was 17 %, compared to 77% in dogs that were left untreated[2], showing the dramatic effect of tiger snake antivenom. The present study showed a mortality rate of 5 % for dogs receiving antivenom, with no deaths in dogs bitten by puff-adders and 2 deaths in dogs bitten by cobras *versus* 12 % in dogs not given antivenom. This suggests that antivenom is an important component of therapy. Most authors recommend early administration of antivenom[1,2,12,14]. As effective treatment with antivenom is expensive, the majority of envenomated dogs are left untreated[12,14]. The quality of antivenom may also play a role in the effectiveness of this therapy. The quality of the antivenom produced by the South African Institute of Medical Research is considered to be excellent[15]. Difference in venom constituents, as different snakes are involved, can be expected and this may be the most important factor responsible for the different mortality rates that have been reported. Time of administration of antivenom following a snakebite also influences the outcome, with early administration being associated with improved outcomes.

In viper envenomation, an increased mortality rate was found to be related to the use of glucocortocisteroids[14]. In the pesent study, as well as in the study by Hackett *et al.*[5], high use of corticosteroids was found. In another study, the use of corticosteroids may have been related to the higher mortality rate, although there was no statistical difference between groups[14]. A recent review on the management of snakebites suggested that there is no or little role for corticosteroids in the treatment of snake bites[11].

CONCLUSION

The highest incidence of puff-adder bites occurred in autumn, with cobra bites peaking in summer. Snake envenomation was found to be associated with high morbidity but low to moderate mortality rates. The haematological and blood chemistry changes were similar to those reported for the viper snake and the rattlesnake. Thrombocytopaenia is a common finding, and can possibly be used to determine if actual envenomation occurred, rather than a 'dry bite' or another cause for the swelling.

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