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Parallels between Russell's viper (*Daboia russelii*) and hump-nosed viper (*Hypnale* species) bites in the central hills of Sri Lanka amidst the heavy burden of unidentified snake bites

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ABSTRACT

Objective: To describe the epidemiology of snake bite in the region and attempt to compare proven Russell's viper with hump-nosed viper bites. **Methods:** All snake bite admissions to the Toxicology Unit of Teaching Hospital Peradeniya over three year from 2006 were included. **Results:** Of the 776 snakebites, 665(86%) were unidentified and non-envenomed. Hump-nosed viper and Russell's viper accounted for 55(7%) and 40(5%) bites respectively, of them, incriminated snakes were found in 36(65%) and 19(48%) cases. The cobra bites-5, krait bites-0. The median ages: Russell's viper bites-41(range 16-66), hump-nosed viper bites-42(range 15-75). The gender incidence, time of bite (>58% daytime) were similar. In hump-nosed viper bite; upper limb involved in 13(36%), happened at home garden in 22(61%), none in paddy fields. In Russell's viper bite; 6(33%) occurred in paddy fields. Dry bites were similar at 5%. In hump-nosed viper bite: local effects 94%, coagulopathy 3%, acute renal failure 3% and one patient died. In Russell's viper bite; local effects 84%, coagulopathy 53%, neurotoxicity 21%. Abdominal pain occurred only in Russell's viper bites 10(53%). **Conclusions:** Overwhelming numbers of unidentified, non-envenomed snakebites are common in the central hills. Some distinctive differences were observed between Russell's viper and hump-nosed viper bites.

1. Introduction

Sri Lanka is a tropical island with great diversity in geography, climate and vegetation, and its sizable lowland dry zone provides the best habitat for the snakes, causing highest incidence of snakebite with a distinctive epidemiology[1,2]. On the contrary, wet highland central region of the island, situated above 480 m from sea level extending up to 2 420 m with hilly terrain capped with ever green vegetation and tea plantation is believed to be less conducive for habitation of venomous snakes. Consequently, less attention being paid to study the pattern of snakebite in the central hills resulting in sparse recent literature except vague estimates on incidence and pattern of snakebite found in a retrospective study dealing with the issue of overall burden of snakebite in the island[2]. Currently, the Central Province of Sri Lanka has a newly established Toxinology and Toxicology Unit in the General Hospital, Peradeniya, which caters for many snakebite patients coming from the central hills of the province and it mirrors the pattern of snakebite in the region (Figure 1). We studied all snakebite admission to this unit over a three year period from 2006 to 2008, in order to establish the epidemiology of snakebite of the region. During this process, it surfaced that two poisonous vipers namely Russell's viper (*Daboia russelii*) and hump-nosed viper (*Hypnale* species) were responsible for most of the poisonous bites amidst heavy load of unidentified non-envenomed bites. These two vipers are widely distributed in Sri Lanka, of them, Russell's viper is responsible for most of the deadly snake bites in the dry zone[1]. However, hump nosed viper is responsible for highest number of nonfatal envenomings[1,2]. But, their epidemiology and effects of envenoming in the hilly Central Province had not been accomplished with accurate data. In a situation of unavailability of offending snake, a distinction of envenoming between these two vipers is difficult even to attempt a syndromic diagnosis. Hypothetically, a possibility of a difference in epidemiology and clinical manifestations

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between dry zone and wet highland viper bites could exist. The aims of this descriptive study were to establish the epidemiology of snakebite in the central hills and, then to compare epidemiological and clinical manifestations between proven Russell's viper and hump-nosed viper bites among concurrent admissions.

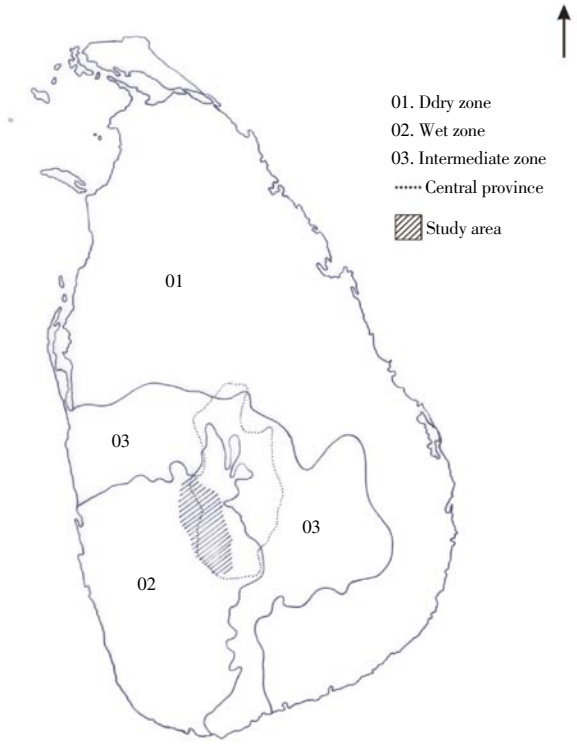

Figure 1. The map of Sri Lanka with climatic zones and the study area.

2. Materials and methods

This was an observational prospective study conducted at the Toxinology Unit of the Teaching Hospital, Peradeniya, which included all snakebite admissions to the Unit from January 2006 to December 2008 coming from the western part of the central hills.

2.1. Identification of snakes

On admission, the incriminated snakes were identified by the authors by studying the morphological characteristics of the dead specimens. Thereafter, all these specimens were formalin preserved and deposited at the adjoining mini museum of the Unit. Later, confirmation of identification was carried out by applying a standard key[3,4]. All proven cases of Russell's viper (RV) and hump-nosed viper (HNV) bites were selected to study parallels between two series of cases. The patients who presented without the killed specimen were excluded from further analysis.

2.2. Clinical assessment and management

The patients were assessed on admission and at least thrice daily during their hospital stay. The protocol of assessment included a detailed clinical history-time, location and site of bite; symptoms such as abdominal pain, pain at the bitten site, double vision, pre-syncope and difficulty in breathing. Further evaluation included signs of neurotoxicity- ptosis, eye movements, power of neck flexors and limb muscles, respiratory rate, tidal volume, level of consciousness; coagulopathy-haematuria, spontaneous bleeding from mucous membranes, 20 min whole blood clotting time (20 WBCT); cardiac status- pulse rate and blood pressure and twelve lead electrocardiogram (ECG); evidence of acute renal failure- urine output, blood urea, serum creatinine and serum electrolytes. Site of bite was examined for local effects at regular intervals for swelling, blistering necrosis and compartmental effects.

The patients were monitored for evidence of envenoming. All proven and suspected cases of Russell's viper and cobra (*Naja naja*) bites with envenoming were treated with polyspecific Indian antivenom (either Vins Boiproduct Limited, Hyderabad or Bharat Serums and Vaccines Limited, Ambernath) as an intravenous infusion. Patients, who developed allergy and anaphylaxis, were managed according to the management protocol of anaphylaxis. Symptomatic treatment included analgesics (paracetamol) for pain and reassurance. All hump nosed viper bites were managed symptomatically as the spectrum of available polyvalent antivenom does not cover it.

2.3. Statistical analysis

The data were computerized and analyzed using the statistical software, SPSS version 10 (SPSS, 1997, Chicago, USA). The epidemiological and clinical data of Russell's and hump-nosed viper bites were compared using proportions and percentages. Numbers less than 5 were compared using adjusted Fisher's exact test.

3. Results

The total number of snakebite patients admitted to the Unit during the three year period was 776 (Table 1). Of them, 665(86%) had no clue about the offending snake as bites took place either in dark or under bushes and vegetations(unidentified snakebites, Table 1). Hump-nosed viper and Russell's viper accounted for 55(7%) and 40(5%) bites respectively. However, of them, incriminated snakes were positively identified in 36(65%) and 19(48%) cases. In the rest the diagnosis was made on the clinical and circumstantial evidence. There were no Ceylon krait (*Bungarus ceylonicus*) and Common Krait (*Bungarus caeruleus*) bites, whilst Cobra (*Naja naja*) accounted for 5 admissions.

3.1. Description of snakes

The voucher specimens of hump-nosed viper (n=16) and Russell's viper (n=5) were examined and deposited in the Department of Medicine, Faculty of Medicine, Peradenoya. Of hump-nosed vipers, 15 were *Hypnale hypnale* and one was *Hypnale zara*. Their total lengths ranged from 180 to 339 mm (average, 292 mm). The lengths of Russell's viper ranged from 534 to 1 420 mm (average 1 014 mm). Other snakes were 8 cat snakes (*Boiga ceylonensis*), two water snakes (*Xenochrophis asperrimus*) and one rat snake (*Ptyas mucosus*).

3.2. Parallels between Russell's viper and hump-nosed viper

Epidemiologic features: The median age of proven Russell's viper bites (n=19) was 41 years (range 16-66 years) and in hump-nosed viper (n=36) 42 years (range

15–75 years). Gender incidence was similar, but males outnumbered females by more than three folds in both groups. The time of bite; the bites mainly took place during daytime and showed no significant difference between two groups (P=0.92; 95% *CI*: −0.21 to 0.33). The bites occurred mostly in lower limbs, but 13(36%) of hump-nosed viper bites were on the upper limb (Table 2). Interestingly, none of the hump-nosed viper bite happened in the paddy field during cultivation, but most of their bite occurred at the home gardens and backyards. On the contrary, in 6(33%) cases, Russell's viper bite occurred in paddy fields (Table 2).

Clinical manifestations: The dry bite rates were similar at 5% and the commonest effect of envenoming was the local effects (84% in RV and 94% in HNV) (Table 2). In one patient with HNV bite in right index finger, surgical intervention was needed due to blister formation and spread of swelling causing compartmental effect. Abdominal pain was unique to RV. Ten patients with RV bite (53%) developed central, colicky pain, developing within half to 2 h after the bite. The incidence of coagulopathy was high in RV at 53% and one patient with HNV bite had transient coagulation defect (Table 2). The signs of neuromuscular paralysis such as ptosis, external ophthalmoplegia were confined to 4 patients (21%) of RV bite, but their tidal volume remained normal. One each from both groups developed acute renal failure that required peritoneal dialysis (Table 2). However, in addition to acute renal failure the patient with HNV bite, who happened to be an alcoholic developed pancreatitis and succumbed to these complications. Fifteen patients (79%) with RV bite with envenoming received antivenom serum 10–20 vials as an intravenous infusion over an hour, under prophylaxis of hydrocortisone infusion and bolus chlorpheniramine. In spite of prophylaxis, 11 patients (73%) developed allergic and anaphylactic reactions. All patients with RV bite recovered fully.

Table 1

Distribution of cases according to the species of snake over 3 years (n, %).

Species of snake	Cases n (%)	Confirmed cases* n (%)
Unidentified snakebite	665 (86)	0 (0)
Hump-nosed viper	55 (7)	36 (65)
Russell's viper	40 (5)	19 (48)
Mildly venomous snakes	8 (1)	8 (100)
Spectacled cobra	5 (0.6)	3 (60)
Non venomous snakes	3 (0.4)	3 (100)
Total	776 (100)	69 (9)

*With dead snake specimens.

Table 2

Comparison of epidemiological and clinical data of two poisonous vipers in the central hills of Sri Lanka: Russell's viper (19 cases), Hump nosed viper (36 cases) (n, %).

Parameter		Russell's viper n (%)	Hump nosed viper n (%)
Sex	Male	15 (79)	28 (78)
	Female	4 (21)	8 (22)
Time of bite	Day	11 (58)	23 (64)
	Night	8 (42)	13 (36)
Bitten limb	Lower	14 (78)	23 (64)
	Upper	3 (17)	13 (36)
Location of bite	Paddy field	6 (33)	0 (0)
	Home garden	4 (21)	22 (61)
Clinical manifestations	Dry bite	1 (5)	2 (5)
	Local swelling	16 (84)	34 (94)
	Abdominal pain	10 (53)	0 (0)
	Coagulopathy	10 (53)	1 (3)*
	Neurotoxicity	4 (21)	0 (0)
	Acute renal failure	1 (5)	1 (3)
	Antivenom given	15 (79)	Not given
	Reactions to antivenom	11 (73)	Not given
	Death	0 (0)	1 (3)

*Significant at P<0.01 level.

4. Discussion

This study found that unidentified, non-envenomed snakebites in the hilly Central region of Sri Lanka account for 86% of all snakebites (Figure 1). Of the poisonous snakes, hump-nosed vipers, Russell's viper and occasionally cobra (*Naja naja*) were identified. There were no Ceylon krait bites (*Bungarus ceylonicus*) in the series, even though it is indigenous to the region, and nor were the common krait bites, which is a dry zone species in the island. Unidentified snakebites have become a burden to the hospital as they require close observation to detect signs of envenoming for minimum of 24 h and for unforeseen complications. The hilly terrain covered with thick plantation, where the access is mainly though footpaths and the abundance of hiding place

in the potholed ground may help the incriminated snakes to hide undetected. In this environment, even a thorn prick might be misidentified as snakebite. It could be argued that non-poisonous snakes prefer to habitat cooler climate in hills than dry zone. However there are no available data on the density of non-poisonous snakes in the region. On the contrary, in a study in 1998, the rate of non-poisonous snake bites in the Anuradhapura District in dry zone ranged from 33% to 55% (the General Hospital and a peripheral Unit) of all snake bites. The same study reported much higher incidence of Russell's viper and hump-nosed viper bites in the same region varying from 14%-48% and 7%-28% respectively[1].

For the first time in the literature, this study attempted to compare epidemiological and clinical features of RV and HNV within the same cohort of patients. Both these snakes are highly poisonous vipers, ubiquitous in the Indian subcontinent and responsible of many bites[5-10]. However, they have different morphological characteristics to be classified as true vipers (*e.g.* Russell's viper) and pit vipers (*e.g.* hump-nosed vipers). and to be classified into three species[3,4]. In Sri Lanka, epidemiology and clinical manifestations of Russell's viper bite in the dry zone had been described explicitly over the last two decades[6,7]. Similarly, there were many reports which described hump-nosed viper bites in Sri Lanka, mainly from the lowland Western province and some from the dry zone, North Central Province[8-10].

We found that both snakes had close similarity in epidemiology, except the location of bite, where RVs had diverse habitats including paddy fields. However, HNV bites never occurred in paddy fields and they dominated home gardens under woods, stone debris, and underneath heaps of moist nuts and leaves. Abdominal pain was a symptom unique to RV bite, while none in HNV group complained of. Similarly, abdominal pain had been documented in more that 80% of patients with RV bites in Anuradhapura in 1997[7]. However, one patient the Indian series of 5 cases of HNV bite had abdominal pain[5]. Coagulopathy was a common manifestation in RV bite (53%) compared to HNV bites (3%) in this study ($P<0.01$). However, there were studies reporting high rates of coagulopathy (21% and 39%) due to HNV bite[8,9]. We found neurotoxicity only in RV, even though, the rate was low (24%) and this would be a useful discriminatory marker. However, in the studies of dry zone, the proportions of patients developing neurotoxicity in RV bites were above 80%[6,7].

Interestingly, we found more complications with HNV bites than RV bites in this series, where all patients with RV bite made full recovery, whilst a death and a disfigurement occurred after HNV bite. The major problem encountered was the high rate of reactions to antivenom in the management of RV bites. However, in RV bite, occurrence of acute renal failure was minimal probably due to the effects antivenom. As a discriminative feature, acute renal failure has no value as it had been a fatal complication of HNV bite in many studies[9,10].

It is obvious that numbers of proven cases of RV and HNV bites were small in this study due to low incidence of their bites in the region, despite the study covered a period of three years. Still, these findings are strong enough to achieve the objectives of this study and these could be extrapolated to the development of management guidelines. In Sri Lanka, identifying the incriminated snake has become a daunting task as very often dead specimens are not available and also due to unavailability of venom detection kits. To overcome this, an attempt had been made to develop a tool of syndromic diagnosis to identify the responsible snake applicable in community survey[11]. However, considering diversity of clinical features influenced by geographical location, the applicability of these tools become inappropriate. In conclusion, this study highlights the magnitude of unidentified snakebites seeking hospital admission and fewer occurrences of deadly venomous bites in the hilly Central region of Sri Lanka. Similarities and differences of the two kinds of viper bites in the region should be taken in account in future development of any syndromic protocols.

Conflict of interest statement

We declare that we have no conflict of interest.

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References

[1] Kularatne SAM. Clinical profile of snake envenoming: a study in North Central Province of Sri Lanka. The 23rd bibile memorial oration in 2001. *Sri Lanka J Med* 2001; **10**: 4-12.
[2] Kasturiratne A, Pathmeswaran A, Fonseka MM, Lalloo DG, de Silva HJ. Estimates of disease burden due to land-snakebite in Sri Lankan hospitals. *Southeast Asian J Trop Med Publ Health* 2005; **36**: 733-740.
[3] Thorpe SR, Pook CE, Malhotra A. Phylogeography of the Russell's viper (*Daboia russelii*) complex in relation to variation in the colour pattern and symptoms of envenoming. *Herpetol J* 2007; **17**: 209-218.
[4] Maduwage K, Silva A, Manamendra-Arachchi K, Pethiyagada R. A taxonomic revision of the South Asian hump-nose vipers (squamata: viperidae: crotalinae: *Hypnale*). *Zootaxia* 2009; **2232**: 1-28. .
[5] Joseph KJ, Simpson ID, Menon NCS, Jose MP, Kulkarni KJ, Raghavendra GB, et al. First authenticated cases of life-threatening envenoming by the hump-nosed pit viper (*hypnale hypnale*) in India. *Trans R Soc Trop Med Hyg* 2007; **101**: 85-90.
[6] Kularatne SAM. Epidemiology and clinical picture of the Russell's viper (Daboia *Russelii Russelii*) bite in Anuradhap-ura, Sri Lanka: a prospective study of 336 patients. *Southeast Asian J Trop Med Publ Health* 2003; **34**(4): 855-862.
[7] Ariaratnam CA, Sjostrom L, Raziek Z, Kularatne SAM, Kodikara arachchi RWK, Sheriff MHR, et al. An open, randomized comparative trial of two antivenoms for the treatment of envenoming by Sri Lankan Russell's viper (*Daboia Russelli Russelli*). *Trans R Soc Trop Med Hyg* 2001; **95**: 74-80.
[8] Premawardhena AP, Seneviratne SL, Gunatilake SB, de Silva NJ. Excessive fibrinolysis: the coagulopathy following Merrem's hump-nosed viper (*Hypnale hypnale*) bites. *Am J Trop Med Hyg* 1998; **58**(6): 821-823.
[9] Ariaratnam CA, Thuraisingam V, Kularatne SAM, Sheriff MHR, Theakston RDG, de Silva A, et al. Frequent and potentially fatal envenoming by hump-nose pit vipers(*Hypnale hypnale* and *H. nepa*) in Sri Lanka: lack of effective antivenom. *Trans R Soc Trop Med Hyg* 2008; **102**: 1120-1126.
[10] Kularatne SAM, Ratnatunga N. Severe systemic effects of Merrem's hump-nosed viper bite. *Ceylon Med J* 1999; **14**: 169-170.
[11] Pathmeswaran A, Kasturiratne A, Fonseka S. Nandasena S. Lalloo DG, de Silva HJ. Identifying the biting species in snakebite by clinical features: an epidemiological tool for community surveys. *Trans R Soc Trop Med Hyg* 2006; **100**: 874-878.