Clinico-epidemiological features of viper bite envenomation: a study from Manipal, South India

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INTRODUCTION Snakebite is an important and preventable health hazard. Viper bites are more common than other poisonous snakebites in human beings. The present study aimed to collate the victim profile of viper bite cases in the region and to determine the pattern, manifestations, complications and the associated risk factors of these bites.
METHODS This was a prospective study of viper bite cases admitted to Kasturba Hospital, Manipal, India between August 2003 and November 2005. The demographic and clinical details of each case were obtained from the patients, their relatives and the patients' hospital records, and analysed.
RESULTS A total of 31 viper bite cases were reported during the study period. The victims were predominantly male and aged 25–55 years. The highest number of cases occurred during daytime in the months of September and October, which coincided with the harvesting season, and involved the lower limbs. 94% of the snakebite victims were farmers, suggesting that this was an occupational hazard. Envenomation was observed in patients with scratch marks, suggesting the importance of keeping the victim under observation in all alleged snakebite cases, even in the absence of clear fang marks. The mortality rate in our study was 6.5%.
CONCLUSION Immobilising and transporting snakebite victims to the hospital and prompt administration of anti-snake venom remain the best way to reduce morbidity and mortality. It is also important to practise correct first aid measures, as otherwise they may cause more harm than good.

Keywords: clinical features, envenomation, epidemiology, South India, viper bite
Singapore Med J 2012; 53(3): 203–207

INTRODUCTION

Snakebite is an important and preventable health hazard. Globally, at least 421,000 envenomations and 20,000 deaths are estimated to occur annually from snakebites; however, these figures may be as high as 1,841,000 and 94,000, respectively. Based on the most conservative country estimates, India had the highest number of envenomations (81,000 per year) and the highest number of deaths (11,000 per year) due to snakebite in the world.[1] Epidemiological studies have confirmed that snakebite in the tropics is a rural and occupational hazard of farmers, plantation workers, herders and hunters.[2,3] The actual incidence of snakebite may be much higher, as the majority of cases occurring in villages go unreported.

Over 2,000 species of snakes are known worldwide, of which around 400 are poisonous. These snakes belong to the families Elapidae, Viperidae, Hydrophiidae and Colubridae.[4] The Viperidae family includes two sub-families: Viperinae (classic vipers) and Crotalinae (pit vipers). Both of these sub-families are present in India and cause envenomation generally in the same spectrum.[5,6] Viper bites are more common than other poisonous snakebites in human beings.[3,7] Of the different varieties of viper, Russell's viper (*Vipera russelli*) commonly inhabits South Asian countries, and Russell's viper bite is regarded as an occupational hazard for the farming community. A fragile symbiotic coexistence of the paddy farmer and Russell's viper is observed.[8] The saw-scaled viper (*Echis carinatus*), on the other hand, is distributed in Uzbekistan, Turkmenistan, Iran, Afganisthan, Pakistan, Northern India and the Arabian Peninsula.[9] The saw-scaled viper does not seem to inhabit the southern part of the Malabar coast.[10]

The study aimed to put together the victim profiles of viper bite cases in this region and to determine the pattern of viper bites, and their various manifestations, complications and associated risk factors.

METHODS

This prospective study on the clinico-epidemiological features of viper bite envenomation was conducted in Kasturba Medial College (KMC), Manipal, South India. Kasturba Hospital (KH) is a tertiary care centre and the teaching hospital of KMC. It provides healthcare services predominantly to the rural population of Udupi district and the adjoining districts in coastal Karnataka and the northern districts of Kerala, which comprise hilly regions, forests and agricultural areas. KH is the main referral centre for cases of snakebite in the region.

All patients admitted to KH with a history of snakebite from August 2003 to November 2005 were included in this prospective research. The condition of each snakebite patient admitted to the hospital was followed up from the time of admission to the end of their hospital stay. The details of each case were obtained from the patients, their relatives and the hospital records. The snakes were identified based on the descriptions given by the patients/

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Table I. Victim profile and related features in viper bite.

Feature	No. of patients (%)
Gender distribution	
Male	18 (58.1)
Female	13 (41.9)
Occupation	
Farming	29 (93.5)
Others	2 (6.5)
Diurnal variation	
Day	20 (64.5)
Night	11 (35.5)
Place	
Outdoors	24 (77.6)
Indoors	7 (22.4)
Site of bite	
Lower limbs	25 (80.6)
Upper limbs	6 (19.4)
Fang marks	
Single	5 (16.1)
Double	20 (64.5)
> 2	4 (12.9)
Scratches	2 (6.5)

relatives as well as the symptoms of envenomation in poisonous snakebites. The local agriculture-dependent populations in the region are well aware of the different varieties of snakes and their identification features. All cases of confirmed viper bite were included in the present study. Of the 31 cases of viper bites, a precise description of the snake was given by the patients/relatives in 23 cases. In eight cases, the killed Russell's viper was brought to the emergency department. Where the victims/relatives were unable to identify the snake, the cases were not included in the study. The included cases were further confirmed based on clinical symptoms of local swelling and haemotoxicity. The demographic and clinical details of each patient were registered, and statistical analysis was conducted using the Statistical Package for the Social Sciences, version 11.0 (SPSS Inc, Chicago, IL, USA).

RESULTS

During the study period, a total of 95 cases of snakebite were identified, of which viper bite constituted 32.6% (n = 31). No saw-scaled viper bite was reported during the study period in this region of South India. The detailed victim profile and related features of viper bite are presented in Table I. The victims of viper bite were predominantly male (n = 18), and the male to female ratio was 1.4 to 1. The mean age of the male victims was 37.9 (range 19–65) years, and that of female victims was 43.5 (range 25–65) years. Decade-wise distribution of male and female snakebite cases is shown in Fig. 1. In the study sample, the majority of snakebite victims were aged 25–55 years (n = 25, 80.6%), with the peak incidence in the 3rd and 5th decades of life. 93.5% (n = 29) of the patients belonged to the farming community (Table I).

The peak incidence in snakebite cases was reported in October, followed by September. The monthly distribution of

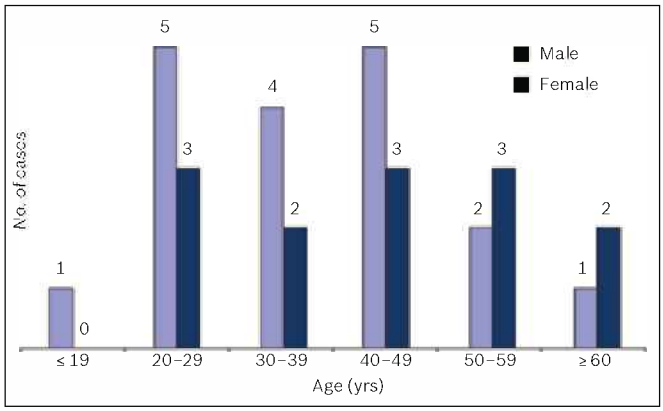

Fig. 1. Graph shows the age distribution of viper bite cases.

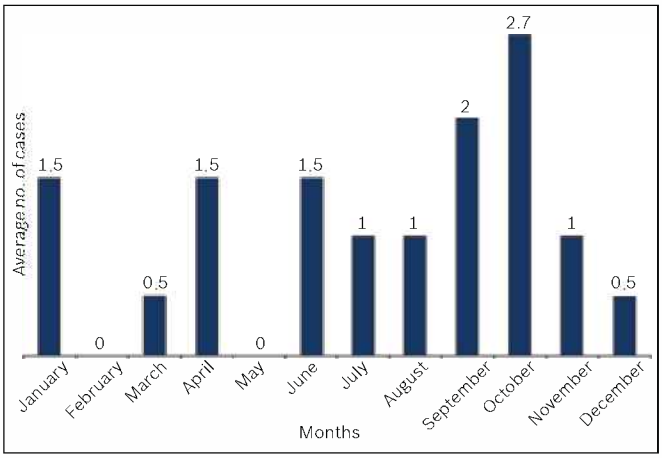

Fig. 2. Graph shows the average monthly number of viper bite cases per year.

Fig. 3. Photograph shows multiple puncture marks on the hand of a viper bite patient.

viper bite cases (average viper bites per month per year) is shown in Fig. 2. Most of the victims in our study were bitten outdoors (n = 24, 77.6%), mostly in the fields during the daytime (n = 20, 64.5%) and on their lower limbs (n = 25, 80.6%) (Table I). Most of these viper bites occurred during daytime (6.00 am to 6.00 pm). Definitive fang marks were seen in 93.5% (n = 29) of victims. Double-punctured fang marks were observed in the majority (n = 20, 64.5%) of cases, followed by single-punctured fang marks (n = 5) and multiple fang marks (n = 4). In two cases, scratch marks were present at the site of the bite (Table I). Fig. 3 shows a viper bite patient with multiple puncture marks.

A total of 23 victims (74.2%) were brought to the hospital within 24 hours of the bite (Table II), and specific treatment was started. First aid measures were employed in 14 victims in our study group, while the other 17 victims did not receive any first aid

Table II. Time duration between viper bite and hospital admission.

Feature	No. of patients (%)
< 1 hr	5 (16.1)
1–6 hrs	14 (45.2)
6–24 hrs	4 (12.9)
1–3 days	4 (12.9)
> 3 days	4 (12.9)
Total	31 (100.0)

Table III. First aid received prior to hospitalisation.

Type of first aid	No. of patients (%)
Tourniquet	10 (32.3)
Incision	2 (6.5)
Tourniquet and incision	2 (6.5)
No first aid	17 (54.8)
Total	31 (100.0)

Table IV. Presenting symptoms of viper bite at the time of admission

Presenting symptom	No. of patients (%)
Swelling	29 (93.5)
Pain	28 (90.5)
Bleeding	7 (22.4)
Vomiting	3 (9.7)
Oliguria	2 (6.5)
Ecchymosis	1 (3.2)
Confusion	1 (3.2)

Table V. Haematotoxic/vasculotoxic manifestations in viper bite patients.

Symptom	No. of patients (%)
Bleeding from the site of bite	20 (64.5)
Ecchymosis	10 (32.3)
Haematuria	15 (48.4)
Haematemesis	1 (3.2)
Epistaxis	1 (3.2)
Intracerebral bleeding	1 (3.2)
None	3 (9.7)

Table VI. Altered blood picture and coagulation profile of patients.

Parameter	Altered status	No. of patients (%)
Total leucocyte count	Increased	16 (51.6)
Platelet count	Decreased	13 (41.9)
Bleeding time	Increased	6 (19.4)
Clotting time	Increased	11 (35.5)
Prothrombin time	Increased	10 (32.3)
APPT	Increased	9 (29.0)

APPT: activated partial thromboplastin time

Table VII. Complications observed following hospitalisation.

Complication	No. of patients (%)
None	2 (6.5)
Cellulitis	29 (93.5)
Reaction to ASV	6 (19.4)
Renal failure	3 (9.7)
Gangrene at bite area	2 (6.5)
Intracranial bleeding	1 (3.2)
Restricted mobility at bite area	1 (3.2)

ASV: anti-snake venom

treatment prior to hospitalisation (Table III). The chief presenting complaint was local swelling and pain at the site of bite, followed by bleeding from the site, vomiting, oliguria, ecchymosis and confusion (Table IV). Local signs of envenomation were seen in 30 cases, while systemic signs of envenomation were present in 28 cases. No local or systemic features of envenomation were observed in a patient with scratch marks, which constituted the only dry bite in the study (3.2%). Systemic haematotoxic/vasculotoxic manifestations in viper bite patients are shown in Table V. Bleeding from the site of the bite was the main manifestation, followed by haematuria and ecchymosis. Blood picture and coagulation profile of the viper bite patients is presented in Table VI.

Specific anti-snake venom (ASV) treatment was given in 28 cases. A number of polyvalent ASV vials were used during the treatment. Around 4–32 ASV vials were administered to each patient, at an average of 11.1 ASV vials per patient. In our study, a test dose was administered in all 28 cases of viper bite with haematotoxic/vasculotoxic features, and the patients were carefully observed for allergic manifestations before the initiation of anti-venom treatment. In six patients who developed allergic reactions to the test dose, polyvalent ASV administration was continued along with corticosteroids and antihistaminic cover. The rate of infusion of ASV was slowed down for the patients who developed allergic reactions to the test dose. Cellulitis has been reported to be the most common complication of snakebites (n = 29). Six patients developed an allergic reaction to the ASV treatment. Renal failure was reported in three cases. The list of complications observed during hospital stay is presented in Table VII.

Most of the patients (n = 28, 90.5%) recovered, while one (3.2%) left the hospital against medical advice before complete recovery. Two fatalities (6.5%) were reported in the study group. Of the two, one patient had received a tourniquet as a first aid measure, while the other did not receive any first aid. Irrespective of first aid treatment, both victims were brought to the hospital for treatment after a delay of three days and survived for a further three days. The cause of death was massive intracranial bleeding, as diagnosed by computed tomography in one case. Consumption coagulopathy was the cause of death in the other patient, who eventually died of acute renal failure (blood urea 170 mg/dL; serum creatinine 7.5 mg/dL) despite repeated dialysis. The mortality rate in our study was 6.5%. No fatal outcome was reported in the victims admitted within 24 hours of viper bite.

DISCUSSION

With regard to viper bites reported in our study, our findings support the view that saw-scaled vipers do not seem to inhabit the southern part of India.[10] Males are affected more often than females, as they constitute the working majority who are actively engaged in farming and other outdoor activities. Our findings concur with those of earlier studies.[3,7,11,12] Involvement of a younger population predominantly during the 3rd and 5th decades of life is probably due to the more ambulant nature of younger people. This age group is commonly involved in farming, thereby increasing the risk of their occupational hazard. Farmers are more prone to accidental contact with snakes while working in the field barefooted, which is a phenomenon observed in India[10,13] and globally.[14] Most of the snakebite cases were reported in September and October. These two months fall in the harvesting season in this region, with abundant vegetation that attracts rodents to the fields, and snakes leave their burrows more frequently in search of prey. Thus, this season with busy agricultural activity makes an ideal setting for snakebites. Most of the victims in our study were bitten outdoors, mostly in the fields during the daytime and on their lower limbs. These bites were mostly due to accidental stamping on a snake while working, an observation that is common to similar studies conducted across India.[7,10,15] Upper limb bites usually occur during harvesting due to accidental exposure to snakes while holding onto grass. Frequent occurrence of viper bites during daytime corresponds to the period of outdoor activities.

No local or systemic feature of envenomation was observed in a patient with scratch marks, which constituted the only dry bite in the study. No sign or symptom of envenomation is observed in about 50% of bites by Malayan pit vipers and Russell's vipers, 30% by cobras and 5%–10% by saw-scaled vipers.[16] We assume that some asymptomatic patients were treated at primary health centres and not referred to the tertiary care centre, which may account for the apparent lower number of dry bites. The small percentage of patients suffering from dry bites in our study may reflect a referral bias to the tertiary care centre.[17] Bleeding from the site of the bite was the main manifestation, followed by haematuria and ecchymosis. Bleeding from the site of the bite was the most common manifestation in haemotoxic-envenomed patients in our study, which was similar to that observed in studies done in Maharashtra[10] and Haryana,[18] India. However, studies conducted in Jammu[19] and Orissa[20] found haematuria to be the most common manifestation. This difference in haemorrhagic manifestations in different studies is attributed to the subtle differences among venoms of the Viperine subspecies in different regions.[15] One patient in our study with multiple scratches showed signs of envenomation (local swelling and haematotoxic/vasculotoxic symptoms). In this patient, local swelling was observed after six hours of the bite, and the haematotoxic/vasculotoxic features developed ten hours post bite. This case emphasises the importance of keeping the patient under observation for at least 12 hours in all alleged cases of snakebite irrespective of the presence or absence of fang marks.

ASV is the only effective and specific treatment available for snakebite envenomation. Specific ASV treatment was given in the majority of cases. 1 ml of polyvalent ASV neutralises 0.6 mg, 0.45 mg, 0.6 mg and 0.45 mg of venom of common cobra, krait, Russell's viper and saw-scaled viper, respectively. Freeze dried (lyophilised) polyvalent ASV is reconstituted with 10 ml of sterile water, and 0.1 ml of it is given intra-dermally as a test dose. The patient is then carefully observed for allergic manifestations for half an hour. The reconstituted venom is then diluted in 500 ml of isotonic saline or 5% dextrose and infused at a constant rate over a period of about one hour. Polyvalent ASV infusion is continued until bleeding tendency is controlled. If there are allergic reactions in the form of fever, itching or urticaria, polyvalent ASV administration is continued with corticosteroids and antihistaminics. The ideal treatment in cases of confirmed identity of the snake is monovalent or monospecific anti-venom, which involves administration of a lower dose of anti-venom protein than poly-specific or polyvalent anti-venom. However, owing to the difficulty in identifying the snake, availability and cost-effectiveness, polyvalent anti-venom remains the main form of treatment in snakebite cases in India.[21,22] A wide regional variation in the composition of venom, however, has been reported;[16] hence, it is recommended to use an indigenously developed ASV that is particular to that region so as to avoid treatment failure. Phillips et al reported that the ASV developed for Indian vipers did not work when used for viper bites in Sri Lanka.[23] The ASV used in the treatment of our patients was manufactured in Bharat Serums and Vaccines Limited.[24]

Soft tissue infections are a major complication of snakebites with local envenomation. The proteolytic properties of snake venom cause extensive tissue destruction and devitalisation, which predisposes the wound to bacterial infection from the snake's indigenous oral flora.[25] Although bacteria are a major cause of wound infection in snakebite patients, the role of prophylactic antibiotics to prevent their formation is debatable.[26] Antibiotics are usually not routinely recommended, and a trial did not show the need for them.[27] Cellulitis was reported in a large number of patients in our study. This higher rate may be related to the large number of patients who received first aid measures in primary health centres and locally. The use of unclean instruments, sucking and cutting on the wound are common risk factors for infection. Also, the venom effects of swelling and blistering are commonly mistaken for bacterial infection. More than 50% of the patients in our study had received first aid treatment. However, inappropriate first aid measures may cause more harm than good. Norris et al's study, which was conducted in a simulated snakebite scenario, reported the inability of physicians and lay people to appropriately apply pressure immobilisation.[28] It is thus recommended that correct first aid measures are practised in such situations.[6]

No fatal outcome was reported in the victims admitted within 24 hours of viper bite, thus suggesting the effectiveness of early specific treatment. The two fatalities reported in our study were

admitted after a delay of three days. Hence, prompt hospital admission and administration of ASV to a snakebite victim is vital. Delays in admission could be attributed to a lack of awareness regarding the hazards of snakebites among the general public, an unrelenting belief in the traditional system of medicine, a lack of proper primary healthcare system and difficulties encountered in transportation of the victim. The mortality rate in our study was 6.5%. A 1%–10% variation in mortality rates from snakebites has been reported in various studies conducted in Davangere,[15] Haryana,[18] Jammu[29] and West Bengal.[30] The high mortality rate in India has been attributed to geographical factors and a predominantly rural population that is dependent on agriculture.

The findings of the present study do not provide an exact representation of the problem in the country and region due to some methodological limitations. Reporting of snakebite and envenomation incidents by health authorities is generally very poor in most developing countries. Retrospective and prospective studies only account for a proportion of all snakebites, since some patients fail to attend health centres. In developing countries, most patients consult a traditional healer first instead of seeking treatment at health centres. Many snakebite cases are treated at the primary healthcare centres and not referred to higher centres, leading to an underestimation of the morbidity status in studies done at tertiary healthcare centres. There may be a similar underestimation of snakebite mortality in the study. An alternative study methodology using household survey to question a representative part of the population has been proposed in order to estimate the morbidity and mortality of snakebites in the community. Another limitation of this study was that the snakes were not identified by herpetologists. Bacterial culture to confirm the wound infection was also not performed. Thus, the true incidence of patients who developed wound infection secondary to snakebite could not be estimated.

In conclusion, the use of protective footwear and proper illumination at night could reduce the incidence of snakebites. Deep vegetation and grassy embankments in the fields must be approached cautiously, especially after the rains. The areas surrounding human dwellings should be kept free from weeds, an ideal shelter for snakes. Blocking crevices and effective rodent control around residential premises would prevent the entry of snakes into human dwellings. Immobilisation and prompt transportation of snakebite victims to the hospital, along with prompt administration of ASV, remains the mainstay to reduce the morbidity and mortality associated with snakebites.

ACKNOWLEDGEMENTS

The present research is a part of an MD dissertation submitted to Manipal University, Manipal, India. We thank the Department of Forensic Medicine for providing the facilities for conducting this study. We are also thankful to Mr Keerthi and Mr Sunder Shettigar for their help during the study, and to the staff and faculty of Emergency Medicine, Kasturba Medical College for their support and cooperation during the study.

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