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Strikes and stripes of the Saw-scaled Viper in the Western Ghats-A case series

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ABSTRACT

We describe 5 cases of envenomation and complications related to saw scaled viper (*Echis carinatus*) bites from the Western Ghats region of Karnataka over a period of 5 years (December 2019-May 2023). Although the smallest member of the Big Four, Saw Scaled viper envenomation is associated with significant morbidity. In our region, envenomation appears to be rare. The careful review of all these cases has suggested VICC with one patient having persistent coagulopathy despite adequate ASV administration, and three patients developing anaphylaxis. It needs to be brought to notice that the complications due to envenoming run high, despite timely administration of ASV. Through these cases, we want to contribute evidence suggesting variable efficacy of Indian polyvalent ASV for *Echis carinatus* bites and the need for updating protocols for the same.

1. Introduction

Saw-scaled Vipers (SSV) are spread across various topographies across Africa, the Middle East, and the Indian subcontinent [1,2], but rarely seen in the eastern and northeastern regions of the country, the Gangetic plains, or the Himalayan foothills [3]. The venom of SSV is hemotoxic and therefore is characterized by manifestations like gingival bleeding, hematuria, epistaxis, hemoptysis, and hematemesis, with rare complications including acute kidney injury (AKI), myoglobinuria, thrombotic microangiopathy, and retroperitoneal bleeding [4–8]. As one of the "Big Four", envenomation by SSV is covered by Indian polyvalent ASV, with the recommended initial dose being 5 vials. There is a growing body of evidence that indicates regional variation of venom across the country, which possibly accounts for varying efficacy of ASV [9,10]. While envenomation by SSV appears to be rare in the Western Ghat region, it still carries a significant morbidity. The cases described below highlight the complication associated with SSV envenomation, and add to the evidence, reiterating the need for a wider venom pool in ASV manufacture or development of regional ASV protocols.

2. Methods

All cases received initial care in the department of emergency medicine and the emergency critical care unit at Kasturba Medical College, Manipal, Karnataka. The cases were identified after reviewing data from the VENOMS registry, a prospective, CTRI registered, single-centric hospital-based registry on envenomation presenting to the Emergency medicine department (CTRI/2019/10/021828). Cases in which evidence of the culprit species was available were screened, and those identified as *Echis* sp. were considered. The evidence was the killed specimen or photograph produced by the attendants and identified by the authors based on morphological features and corroborated by an

Abbreviations: SSV, Saw-scaled Viper; AKI, Acute Kidney Injury; ASV, Anti-snake Venom; WHO- SEARO, World Health Organization Regional Office for South-East Asia; PLA2, Phospholipase A2; SVSP, Snake Venom Serine Protease; SVMP, Snake Venom Metalloproteinase; Snaclec, Snake C-Type Lectins; VICC, Venom Induced Consumptive Coagulopathy; ART, Antiretroviral Therapy; INH, Isoniazid; ECVTN, *Echis carinatus* venom from Tamil Nadu; ECVGO, *Echis carinatus* venom from Goa; HIV, Human Immunodeficiency Virus.

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expert. Written informed consent was obtained in all cases. Indian polyvalent ASV administered at our center was manufactured by Bharat serums. Treatment protocols followed were as per the National Standard Treatment Guidelines (2016) and the WHO SEARO guidelines [11,12].

3. Case details

3.1. Case 1

A 42-year-old male, with no known comorbidities, was clearing dry leaves around 7 am on the 28th of December 2019, when he was bitten by a Snake on his left hand, following which he developed bleeding from the bite site, gingival bleeding, one episode of hematemesis, and swelling of the bitten limb. He reported to a government hospital, where 10 vials of ASV were started following which he developed shock, with a systolic BP of 60 mm Hg recorded. ASV was stopped and he was transferred to our centre. On arrival, he was tachypnoeic, with a blood pressure of 70/30 mm Hg, and a heart rate of 86/min. 20 WBCT test was positive. He was stabilized with chlorpheniramine maleate, Hydrocortisone, and epinephrine infusion. Coagulation parameters were deranged with TEG showing a severe hypo-coagulable state. CPK was 484 $U.L^{-1}$. Urine analysis suggested haematuria. He was treated with 10 vials of ASV, followed by another 10 vials on day 2, in addition to IV antibiotics, analgesics, and Vitamin K supplementation. On Day 2 CRP was 22.25 mg. dL^{-1}. The patient was discharged on day 5 when lab parameters normalized, and limb oedema decreased (Tables 1 and 2).

3.2. Case 2

A 36-year-old male, with no known co-morbidities was bitten by a snake on the 18th of January 2021, on the right hand while starting his bike following which, he developed signs of local envenomation, up to the elbow. He did not have any signs of haemorrhage. An unknown dose of ASV was administered at the local hospital, following which he had an episode of vomiting. ASV was stopped and he was transferred to our centre. Due to deranged coagulation parameters, he was administered 10 vials of ASV, followed by another 10. His LDH was elevated (395 $U.L^{-1}$), but the peripheral smear did not suggest haemolysis. His CPK was 827 $U.L^{-1}$. Arterial and venous doppler of the bitten limb did not detect thrombosis. He had a mild elevation of creatinine with decreased urine output. On day 2, platelet count dropped to 130000, but improved on day 3(155000). He was managed conservatively with IV antibiotics, analgesics, and limb elevation with glycerine MgSO4 dressing, and discharged with full recovery on day 3 (Tables 1 and 2).

3.3. Case 3

A 49-year-old male, with no known co-morbidities was bitten by a snake on the 10th of December 2021, on the left big toe around 8:00 AM outside his house. He had swelling and redness of the bitten limb but no bleeding manifestations. He first resorted to Ayurvedic treatment and then went to the local hospital where he was administered 5 vials of ASV to which he developed urticaria. ASV was stopped and he was referred to our centre. On arrival, he was administered an antihistamine, Hydrocortisone, and 10 vials of ASV. This was followed by another 10 vials of ASV at 9 hours due to persistent coagulopathy. The coagulation profile improved over the course of 3 days where the PT was 11.4 and INR was 1.03. Serum creatinine increased to 1.02 on Day 2 but later dipped to 0.85 mg/dL. Local envenomation was managed with Amoxicillin-clavulanate, limb elevation, dressing, and analgesics. He was discharged on day 5 after the resolution of local envenomation and coagulopathy (Tables 1 and 2).

3.4. Case 4

A 30-year-old male, with no known comorbidities, was transferred to our centre on the 15th of February 2022(day 7) following a snakebite on the left hand. He first sought Ayurvedic care, following which he was admitted to a local hospital within 1.5 hours of the bite. During this admission, he received a total of 25 vials of ASV, 20 units of Fresh Frozen Plasma (FFP), and 4 units of Cryoprecipitate. He had persistent coagulopathy, haematuria, and abdominal pain, due to which he was transferred to our centre. He received 10 vials of ASV at our centre, along with Tranexamic acid and 1 PRBC transfusion. The initial platelet count was 142,000. D-dimer was >10 mcg. mL^{-1}. Arterial and venous dopplers of the bitten limb did not reveal thrombosis. He improved and was discharged after 7 days in our hospital. (Tables 1 and 2).

3.5. Case 5

A 49-year-old male, known case of retroviral disease on ART (Tenofovir, Lamivudine, Efavirenz), old pulmonary tuberculosis, and INH-induced peripheral neuropathy, was bitten on his left hand while collecting firewood on the 21st of May 2023. A bite mark was present on the left wrist. He developed swelling of the bitten limb. He immediately killed and collected the snake, tied a tourniquet above the wrist, and lost consciousness. His attendants also reported involuntary movements of both upper limbs and lower limbs with bleeding from the oral cavity. No up rolling of eyeballs or incontinence was noted. His sensorium continued to remain altered. He received 5 vials of ASV, tetanus prophylaxis, and antihistamine at a local centre, and was transferred to our centre. On arrival, 20 WBCT was found to be positive, for which he received 10 vials of ASV. Examination revealed blood staining of the oral cavity, hematoma of the tongue, and altered mental status with a GCS of E2V1M5 with equal, reactive pupils and no lateralizing signs. His coagulation profile was deranged, with TEG suggesting VICC. His CK (1192 $U.L^{-1}$) and LDH (412 $U.L^{-1}$) were also elevated. Troponin T was 0. 209 ng. mL^{-1}. He received another 20 vials of ASV on day 1 with a total of 11 more vials infused over the next 2 days (Tables 1 and 2). Over the course of his stay, his sensorium improved, and his coagulation profile normalized. CT and MRI of the brain were done which were both reported to be normal. He was discharged on day 4 with a follow-up planned.

4. Discussion

Bites by *Echis* species are common globally, as well as in other parts of peninsular India [13,14], but incidence of bites in the Western Coastal parts of India appears to be low [15–17], with only five proven cases recorded at our centre from 2019 to 2023 as per the VENOMS registry. However, there are many limitations to classifying this as rare. The cases reported are from a single tertiary care centre, where cases of snakebite are referred from other centres. Only cases with evidence of culprit species (photographic or dead specimen) have been considered for this report. The number of cases without evidence of culprit species is much higher, and syndromic identification is not reliable in the study region due to the presence of other medically significant viperine species. The habitat, the grassland plateaux of the Western Ghats is niche, with limited human activity, but with changing land use patterns, the incidence of bites by Saw-scaled Vipers in this region is expected to increase (Figs. 1 and 2).

The species found in peninsular India are *Echis carinatus carinatus* and E.c. *sochureki*, being found in Northern India and Rajasthan. E. *carinatus* is found in the study region ofWestern coastal Karnataka (Figs. 1 and 2). Proteomic studies reveal differences in venom profiles of specimens from different parts of the country [18]. It is now known that the available ASV is not efficacious against *E.c. sochurekii* [3,19].

Echis venom is predominantly hemotoxic and cytotoxic with enzymes such as PLA2, SVMP, and snaclec as major components (70 %), and other enzymes including SVSP, L-amino acid oxidase (LAAO), Disintegrins, Renin-like Aspartic protease(AsP), Hyaluronidase and Phospholipase B. (Table 3) [20]. Comparative proteomics across the country

Table 1
Laboratory parameters of the patients with treatment administered with 0 H as bite time.

Time	PT(s)	INR	APTT(s)	TEG	Serum Cr (mg.dL^{-1})	Fibrinogen(mg.dL^{-1})	ASV/Blood products
Case 1							
2 H	-	-	-	-	-	-	ASV 10 vials
7 H	>120 s		55.8 s	Severe hypocoagulable	1.24	-	ASV 10 vials
15 H	19.5 s	1.84	29.3 s	-	-	34.7	ASV 4 vials
23 H	15.2	1.40	-	-	1.30 mg/dL	-	ASV 6 vials
29 H	13.5	1.24	27.1 s	-	-	-	-
35 H	13.2 s	1.21	27.1	-	-	-	-
45 H	12.4 s	1.13	28.8 s	-	1.08	-	-
Case 2							
1.5 H	-	-	-	-	-	-	ASV (unknown quantity)
3 H	>120	-	-	-	1.52	-	ASV 10 vials
10 H	24.9	2.37	29.5	-	-	-	ASV 10 vials
23 H	15.1	1.39	24.3	-	-	-	-
30 H	13.9	1.27	24	-	1.04	-	-
54 H	11.0	0.99	23.6	-	1.09	-	-
Case 3							
4 H	-	-	-	-	-	-	ASV 5 vials
6 H	>120		>120	Severe hypocoagulable	0.88	-	ASV 10 vials
14 H	19.3	1.46	-	-	-	11.6	ASV 10 vials
22 H	14	1.28	26.1	-	1.02	-	-
46 H	11.4	1.03	-	-	0.85	-	-
Case 4 *Patient arrived on day 7 after care at a local hospital. Hours calculated are from time of arrival to our centre							
2 H	-	-	-	-	-	-	ASV 25 vials, 20 FFP, 4 Cryoprecipitate
DAY 7	>120		35.3	Severe hypocoagulable	0.76	-	4 Cryoprecipitate
+4 H	>120		36.9	-	0.78	<20	ASV 10 vials
+12 H	20.9	1.91	-	-	0.69	-	-
+18 H	15.2	1.37	-	-	-	-	-
+30 H	12.3	1.09	25.4	-	0.93	-	1 PRBC
+54 H	11.8	0.88	-	-	-	-	-
+78 H	11.5	1.02	24.2	-	0.76	-	-
Case 5							
0 H	-	-	-	-	-	-	ASV 5 vials
4 H	>120	-	>120	Severe hypocoagulable	1.22	-	ASV 10 vials
							ASV 10 vials
10 H	36.1	3.43	-	-	-	<10	ASV 10 vials
16 H	17.3	1.57	33.8	-	1.16	-	ASV 5 vials
26 H	13.7	1.23	-	-	1.02	-	ASV 6 vials
40 H	11.9	1.06	30.5	-	-	-	-
50 H	11.4	1.01	-	-	-	-	-
64 H	10.9	0.96	-	-	-	-	-

Table 2
Summary of treatment administered.

Patient no.	ASV peripheral centre(vials)	ASV total(vials)	Antihistamine	Hydrocortisone	Inotrope	Blood Products
Case 1	10	30	-	+	Adrenaline infusion	-
Case 2	unknown	20	+	+	-	-
Case 3	5	25	+	+	0.3 mL subcutaneous adrenaline	-
Case 4	25	35	-	-	-	+
Case 5	5	46	+	+	Noradrenaline infusion	-

Fig. 1. Saw-scaled Viper specimen (Case 3). About 30 cm in length. Note the short, rounded snout with the keeled scales and pale cruciform pattern over the dorsum of the head.

Fig. 2. Representative image of *Echis carinatus* specimens from Goa.

Table 3
[10,21] Venom composition of Saw-scaled Viper, with mechanism of action, clinical effects, and percentage composition in specimens studied from Goa.

Venom composition	Mechanism of action	Clinical effect	ECVGO
Phospholipase A2 (PLA2)	Generalised breakdown of phospholipids in cell membranes	Haemolytic activity, haemorrhage, myotoxicity, cardiotoxicity	11.3 %
Snake venom metalloproteases (svMP)	Breakdown of extracellular fibrinogen, basement membrane	Haemorrhagic symptoms	37.44 % (P III)
Snaclecs(snake lectins)	Inhibit/activate platelets	Consumptive coagulopathy	27.86 % 5.33 %
Snake venom serine proteases(svSP)	Acts as a catalyst in blood coagulation cascade	Causes hemorrhagic symptoms	
L-Amin acid oxidases	Oxidative deamination of L-amino acid in the process of which hydrogen peroxide is released	Oedema, platelet aggregation, apoptosis, anticoagulation	11.9 %

(Tamil Nadu, Goa and Rajasthan) revealed variations in the venom composition [10], accounting for the variable efficacy of the available ASV, which has a limited venom pool. Variations have not been studied within smaller geographic regions. The culprit specimens in this study are assumed to have a similar venom profile to specimens studied in Goa (ECVGO), as they share similar habitat and geographically, are more proximal [18] (Table 3) (Figs. 2 and 3). Indian polyvalent antivenin contains Immunoglobulins which can neutralize toxins either by direct inhibition, blocking the catalytic site, or by indirect inhibition, where it binds to other sites. The neutralization is often measured by quantifying antivenom-venom complexes. The in-vitro studies done show contrasting evidence in terms of neutralisation capacity of ASV, with one suggesting no significant difference between ECVTN and ECVGO and the other showing significant differences [21]. There may also be variation of efficacy among different brands of ASV. The study of regional variation is very important to guide the selection of venom pools and improve the quality of ASV.(Fig. 3).

All patients received primary care at local hospitals with ASV dosing as per standard treatment guidelines, before being transferred to our centre. All patients except patient 3 were bitten on the upper extremity. While the anatomical site may influence prognosis, inferences are not drawn due to multiple confounding factors such as different time to hospitalization, use of native medicine and pre-admission ASV administration. All patients received timely ASV prior to transfer, with quantities varying from 5 to 25 vials. Documentation of the brand of ASV administered at the local hospitals was not available. Three patients developed anaphylaxis to ASV, and two patients required inotrope infusions. The incidence of anaphylaxis increases the risk of administration of ASV in the primary care setting. This is also compounded by a dearth of trained emergency medical services in the prehospital setting. There is a need for paramedics or doctors trained in advanced resuscitative procedures in the pre-hospital setting, considering the topography and the possibility of bites occurring in remote regions with limited road access (Table 2).

Whereas all patients had local envenomation and laboratory proven VICC, two presented with bleeding from the oral cavity, one had hematemesis and one haematuria. Patient 5 presented with altered mental status and a seizure-like event, although CNS imaging did not reveal any structural abnormality. The retroviral disease and his ongoing treatment could have complicated the presentation, but there is a dearth of literature of the interaction of snake venom and HIV [22]. Only two patients had mild acute kidney injury, which resolved with supportive care and ASV. One patient received blood transfusions in addition to ASV. All had local envenomation, which improved with conservative management. All patients recovered without any residual disability. Patient 4 required 14 days of hospitalization, while others required 3–5 days. The rate of complications due to envenomation appears to be high, despite timely administration of ASV. Notably, patient 4 presented with severe VICC on day 7 of envenomation, despite administration of 25 vials of ASV and transfusion of blood products. The patients received an average of 31 vials of ASV with the minimum being 20 and maximum of 46 vials. This is much higher when compared to the doses recommended in the national and WHO-SEARO guidelines where 5 and 4–6 vials as an initial dose are recommended [12,23].

Recommended and timely initial dosing of ASV at the primary care level does not appear to have prevented or corrected VICC, as observed in Cases 1, 4, and 5. These cases corroborate some findings of Bhatia et al. [21], with the culprit snakes being possibly similar to the specimens studied from Goa.

The differences in timeline make comparison of the cases difficult. Standardization based on timeline is challenging in this region as prehospital systems are not yet mature, and factors such as distance, terrain, resource and traditional practices greatly affect hospitalization times.

Another limiting factor is the small sample size, from which definitive conclusions regarding treatment protocols cannot be derived.

Laboratory-based studies may serve as a guide to ASV dosing, but ultimately, this needs to be studied in the clinical setting. Perhaps the way forward would be regional ASV dosing protocols, based on clinical trials. In the meantime, ASV manufacturers may consider expanding venom pools for ASV manufacture based on regional studies [9,24] and improve the quality of ASV to minimize the incidence of anaphylaxis [25].

5. Conclusion

These cases individually highlight the morbidity, resource requirement, limitations of standard treatment protocols and quality of

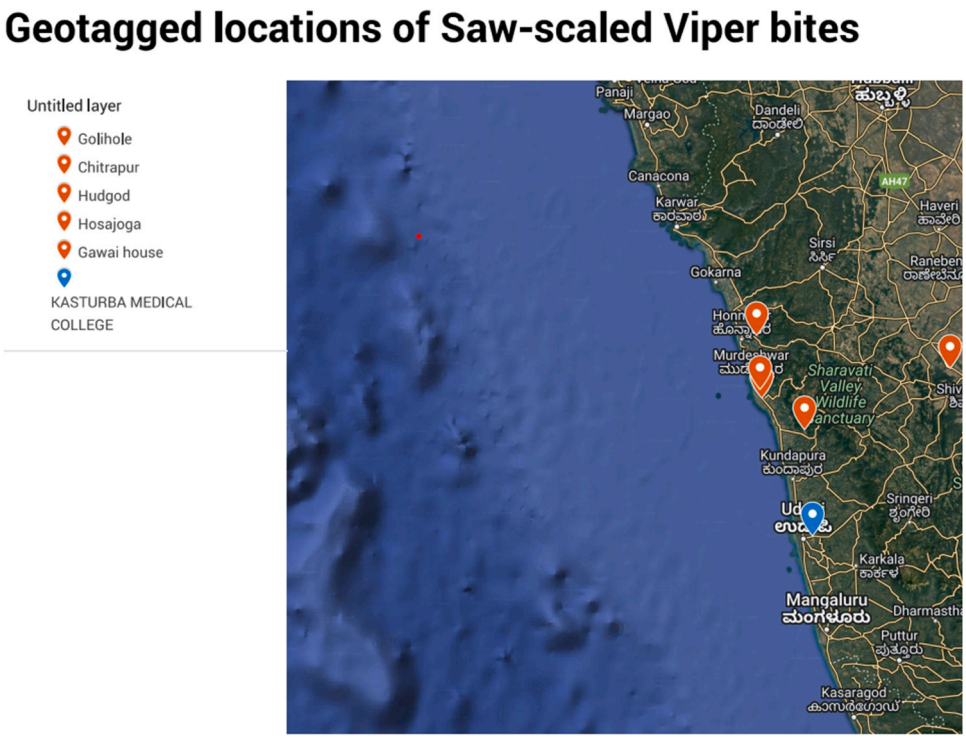

Fig. 3. Geotagged locations of bites by the Saw-scaled Viper. All locations are in the Western Ghats, with four near the coast and one further inland. The treating hospital is marked in blue.

available antivenin. The incidence of anaphylaxis is concerning, particularly in the primary healthcare setting. There is a need for larger studies on ecology, venom profile and treatment protocols in envenomation by Saw-scaled Vipers in Western Coastal India.

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Dr. Freston Marc Sirur: Writing – review & editing, Conceptualization. **Dimple Shekhawat:** Writing – original draft, Data curation. **Vrinda Lath:** Writing – review & editing, Writing – original draft, Data curation, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

The authors have not used generative AI to formulate the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

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