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CASE REPORT

The Treatment of Unidentified Hematotoxic Snake Envenomation and the Clinical Manifestations of a *Protobothrops kelomohy* Bite

Athitarn Tangtermpong, MD[1]; Kanokporn Pinyopornpanish, MD[2]; Taksa Vasaruchapong, DVM[3]; Boriboon Chenthanakij, MD[4]; Kanokwan Pinyopornpanish, MD[5]

[1]Nakornping Hospital, Chiang Mai, Thailand; [2]Department of Family Medicine, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand; [3]Snake Farm, Queen Saovabha Memorial Institute, The Thai Red Cross Society, Bangkok, Thailand; [4]Department of Emergency Medicine, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand; [5]Department of Internal Medicine, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand

Hematotoxic snake envenomation is clinically important and has serious complications. This case report describes the clinical manifestations of a bite from a newly described species of hematotoxic snake and the outcomes of treatment using locally available antivenom and supportive management. A 39-y-old male was bitten on his right ankle by an unidentified snake. The patient developed coagulopathy, rhabdomyolysis, and clinical signs of compartment syndrome of his right leg within the first day. Eight doses (30 mL, or 3 vials per dose), or a total of 240 mL, of hemato-polyvalent antivenin (Thai Red Cross, Thailand) were given. Aggressive intravenous hydration and alkalinization of urine were performed, and a fasciotomy was performed for the treatment of suspected compartment syndrome. The patient's clinical symptoms and laboratory results indicated progressive improvement during the 5 d of hospitalization. The snake was later identified as *Protobothrops kelomohy*, a novel snake species with no clinical data available regarding its envenomation of humans. This case shows that *P kelomohy* envenomation can produce severe effects that occur both locally and systemically. The benefits of the use of polyvalent antivenom in this situation were unclear. However, with supportive treatment in conjunction with serial clinical and laboratory monitoring, the patient recovered, albeit after 7 d of hospitalization.

Keywords: Protobothrops, lance-headed pit viper, hematotoxic snake

Introduction

A venomous snake bite is a serious medical condition. Envenomation by a hematotoxic snake causes many serious complications, including coagulopathy, rhabdomyolysis, acute kidney injury, and local tissue necrosis. In addition to supportive treatment, specific antivenom is recommended to reduce the occurrence of serious complications and decrease the severity of the outcome. Patients who have at least one of the following abnormalities fulfill the requirements for receiving specific antivenom: spontaneous systemic bleeding, thrombocytopenia (<100,000/cu mm), incoagulable blood assessed by the 20-min whole blood clotting test (20WBCT), prolongation of prothrombin time, acute kidney injury, generalized rhabdomyolysis, or severe local envenoming for which the benefits outweigh the risk of antivenom reaction.[1]

In Thailand, 3 hematotoxic snakes have been recognized as common medically important snakes: green pit vipers (*Trimeresurus* spp), Russell's viper (*Daboia siamensis*), and the Malayan pit viper (*Calloselasma rhodostoma*).[1] A specific monovalent antivenom against each snake and a polyvalent antivenom combining all 3 snake antivenoms are available in Thailand. These are produced by the Queen Saovabha Memorial Institute, Thai Red Cross Society, Thailand.

When encountering severe complications from an unknown hematotoxic snake, the decision with regard to

Corresponding author: Kanokwan Pinyopornpanish, MD, Department of Internal Medicine, Faculty of Medicine Chiang Mai University, 110 Inthawarorot Rd, Sriphum, Muang, Chiang Mai 50200; e-mail: kpinyopornpanish@gmail.com.

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antivenom administration can be challenging. Uncertainty about the efficacy of an antivenom against the venom of an unknown snake is of great concern. This case report describes the clinical manifestations of envenomation by an unknown hematotoxic snake. The snake was later identified as an Omkoi lance-headed pit viper (*Protobothrops kelomohy*), a new pit viper species.[2] The outcome of treatment when using locally available antivenom and supportive treatment are reported.

Case Presentation

A 39-y-old male was bitten on his right ankle by a snake in a field in the Omkoi district, Chiang Mai province. He reached a district hospital 4 h after the bite. The snake is shown in Figure 1A. The head of the snake was cut off by the patient. The observable phenotypic characteristics did not match any previous reports of venomous snakes in Thailand.

Prehospital first aid involving splinting of the bitten limb was appropriate. Upon arrival at the emergency department, 2 fang marks were observed on the medial side of his right ankle, as shown in Figure 1B. A venomous snake was suspected, but the type could not be specified. Serial laboratory examinations were performed, as described in Table 1. The initial laboratory results showed leukocytosis. The initial venous clotting time determined by the 3-tube bedside coagulation test[3] was coagulable within 30 min. The patient received supportive management, including wound cleaning and acetaminophen as an analgesic.

Ten hours after envenomation, the patient had a prolonged venous clotting time. His right leg started to swell, and nonhemorrhagic blebs formed. The right dorsalis pedis arterial pulse became impalpable, and compartment syndrome was suspected. At that time, the snake was considered to be a Malayan pit viper; therefore, a single dose of 50 mL (5 vials) Thai Red Cross monospecific Malayan pit viper antivenom was given.

The patient was transferred to a provincial hospital. The transfer process took 8 h, after which the patient's clinical condition was reevaluated. The right leg was markedly swollen and tense with pain on passive leg stretching. Paresthesia was noted in the right leg, and the dorsalis pedis pulse could not be palpated. A detailed examination of the snake found that the stripe pattern differed from that of a Malayan pit viper, and it was suspected that the snake was a different hematotoxic species. Therefore, an initial dose (30 mL or 3 vials) of Thai Red Cross hemato-polyvalent antivenin was given in place of a monospecific antivenom at 18 h after the bite for correction of the coagulopathy. Despite the introduction of antivenom and leg elevation, the patient's right leg swelled progressively (39.5 cm measured at 10 cm below the tibial tubercle, compared to 35 cm on the left side). An intracompartmental pressure monitor was unavailable; therefore, the diagnosis of compartment syndrome was made clinically.

Figure 1. Characteristics of the snake and its fang marks. (A) The snake. (B) Fang marks (arrows) on the medial side of the right ankle of the patient (with permission from the patient). (C) *Protobothrops kelomohy* (a new species of snake) collected from the same location as the snake *(photo by T. Vasaruchapong).*

An emergency fasciotomy was performed at 19 h after the bite. Fresh frozen plasma was given for bleeding prophylaxis, and the 20WBCT was normalized before the procedure. The intraoperative blood loss was 200 mL. The follow-up laboratory results were consistent with rhabdomyolysis. The patient was treated with aggressive intravenous hydration and alkalinization of urine.

After the operation, 20WBCT administration every 6 to 8 h and daily prothrombin time testing were used to reevaluate blood coagulation. The 20WBCT on day 2 after the bite was incoagulable, and even after several repeated doses of polyvalent antivenom, incoagulable blood was still observed. The antivenom (30 mL or 3 vials per dose) was given and repeated every 7 to 12 h based on coagulation tests. The total dose given to the patient was 240 mL. No adverse antivenom-related events were observed.

There was progressive clinical improvement without any clinical bleeding. The 20WBCT was normal 5 d after envenomation, and the patient was discharged after 7 d of hospitalization. He underwent physical therapy sessions, and the fasciotomy wound was sutured. The wound was

Table 1. Laboratory investigations

Laboratory data	*Time after envenomation*								
	4 h	*10 h*	*18 h*	*2 d*	*3 d*	*4 d*	*5 d*	*6 d*	*7 d*
Hb ($g \cdot dL^{-1}$)	15.6	-	16.7	14.3	12.8	11.0	-	10.3	-
Hct (%)	46.7	-	49.9	49.9	39.6	34.0	-	32.0	-
Platelet ($K \cdot uL^{-1}$)	157	-	165	143	141	140	-	200	-
WBC ($K \cdot uL^{-1}$)	14.4	-	14.1	14.3	10.5	6.4	-	5.8	-
Neutrophil (%)	88.2	-	84.7	84.2	73.0	69.7	-	65.7	-
Lymphocyte (%)	7.9	-	10.3	9.6	16.6	17.9	-	19.4	-
BUN ($mg \cdot dL^{-1}$)	17	-	15	13	9	8	8	9	9
Cr ($mg \cdot dL^{-1}$)	1.3	-	1.0	1.3	1.1	0.9	1.0	1.0	0.9
CPK ($U \cdot L^{-1}$)	-	-	14,407	13,105	7322	4585	2531	-	661
AST ($U \cdot L^{-1}$)	-	-	356	324	-	-	-	68	-
ALT ($U \cdot L^{-1}$)	-	-	53	52	-	-	-	33	-
VCT	C	I (>30 min)	-	-	-	-	-	-	-
20WBCT	-	-	C	I	I	I	C	C	C
PT (reference 11.6–14.3)	18	-	15	15	14	15	-	-	-
PTT (reference 25.4–33.7)	31	-	29	30	28	30	-	-	-
INR	1.6	-	1.2	1.2	1.1	1.2	-	-	-

ALT, alanine transaminase; AST, aspartate transaminase; BUN, blood urea nitrogen; C, coagulable; Cr, creatinine; CPK, creatine phosphokinase; Hb, hemoglobin; Hct, hematocrit; I, incoagulable; INR, international normalized ratio; PT, prothrombin time; PTT, partial thromboplastin time; 20WBCT, 20-min whole blood clotting test; VCT, venous clotting time; WBC, white blood cell count.

completely healed at 3 mo at the follow-up visit, with full functional recovery.

Discussion

There are 2 major clinical findings from this case report. First, this case demonstrates the clinical manifestation of envenomation by *P kelomohy*, a new species of hematotoxic venomous snake. Second, when encountering an unknown venomous snake bite, the judicious use of locally available antivenom as an antidote is essential. Serial clinical and laboratory monitoring, together with adequate supportive management, are equally important in the achievement of a good outcome.

This case report describes an incident in which the patient was bitten by an unknown hematotoxic venomous snake. The observable characteristics of the snake differed from the species commonly found in Thailand. Its dorsal color pattern resembled the cat snake (*Boiga multomaculata*). However, the large size and character of the keeled scales, with no enlarged vertebral scales, made the snake markedly different. One of the snakes responsible for common envenomation in this area is the Malayan pit viper (*Calloselasma rhodostoma*), which also differs from the snake involved in this incident: The Malayan pit viper has a stout body and smooth dorsal scales, with a brown triangular pattern along both sides of the body.[4] This unknown snake was taken to Snake Farm, Queen Saovabha Memorial Institute, Thailand, for further identification.

The background color was grayish-brown with large brown blotches along the dorsal part of the body and smaller blotches of the same color along both sides. The number of midbody dorsal scales was 23, all keeled with no enlarged vertebral scales. The number of ventral scales was greater than 200, and the ventral color was white with a pale brown powder effect scattered along the ventral surface. The tail was brown, and all subcaudals were paired. These specific features were used by the experts to identify the snake as an Omkoi lance-headed pit viper (*P kelomohy*, shown in Figure 1C).[2]

Protobothrops spp. commonly originate in Southwestern China and are distributed across North India, Myanmar, China, Laos, Taiwan, Vietnam, Thailand, and Japan. Before this occurrence, 14 species were recognized.[5] In Thailand, only 1 case involving *Protobothrops* spp. has been reported, specifically *Protobothrops mucrosquamatus*.[6] The patient envenomated on that occasion had a dry bite with no significant clinical signs and symptoms; therefore, on that occasion, treatment and use of antivenom were not required. The morphology of *P kelomohy* and *P mucrosquamatus* differs in the number of midbody, ventral, supralabial, infralabila, and loreal scales. The vertical stripes from the eyes in *P kelomohy* are also absent in *P mucrosquamatus*.

Studies regarding the clinical symptoms of *Protobothrops* spp. bites from other countries show that envenomation may cause many complications similar to those in this case.[7-10] In this case report, *P kelomohy* venom could produce both local and systemic effects.

The clinical symptoms included suspected compartment syndrome in the bitten limb and systemic involvement, including coagulopathy and rhabdomyolysis, which developed within the first day of the bite, indicating the severity of the venom. These conditions need close clinical and laboratory monitoring, together with supportive management.[1,11] Aggressive intravenous hydration, acidosis correction, and alkalization of urine need to be used to restore renal function and prevent progression of rhabdomyolysis.[1,11] Antivenom is required in clinically severe cases. The use of specific antivenom against *P mucrosquamatus* has been studied in Taiwan. At least 3 vials of antivenom were required in 66% of patients, and the mean length of hospital stay was 7.5 d.[7]

When there is a clinical suspicion of compartment syndrome, it should always be confirmed with other available tools because the envenomation itself could also produce signs mimicking compartment syndrome; clinical diagnosis of compartment syndrome could lead to incorrect conclusions, leading to adverse outcomes.[12] If an intracompartmental pressure monitor is available, assessment and monitoring of this parameter is crucial to enhancing treatment and outcome. Fasciotomy should be considered only in cases in which sustained elevation of intracompartmental pressure can be demonstrated by direct measurement.[1] This is because most patients do not need this operation, and unnecessary fasciotomy could lead to prolonged morbidity.[12] In a resource-limited hospital where a pressure monitor is unavailable, in addition to serial physical sign monitoring, Doppler ultrasound is useful for the assessment of blood flow and patency of arteries and veins. Magnetic resonance imaging, if available, could also be a useful option for the assessment of edema and hemorrhage in fascial compartment muscles.[1] These investigations are essential in diagnosis and guidance for management to avoid unnecessary fasciotomy.

In a situation involving an uncertain species of snake, polyvalent antivenom may be considered if it is believed to have a paraspecific efficacy.[13] The Thai green pit viper antivenom against *Trimeresurus albolabris* demonstrated potential cross-reactivity and cross-neutralization (in vivo and in vitro) in neutralizing a wide range of *Trimeresurus* venoms.[14,15] However, the cross-neutralization of green pit viper antivenom to *Protobothrops* spp venoms had not been reported. Two cases involving the use of green pit viper antivenom against *Protobothrops mangshanensis* have been reported.[8,9] These patients had a delay in the onset of complications involving bleeding observed on days 5 and 6 after envenomation. Both cases showed improvement of coagulopathy within 24 h after the first dose of green pit viper antivenom. In the current case report, the dosage of antivenom used was considered to be high, but the effectiveness of polyvalent antivenom, which is manufactured to be effective against the different genera of hematotoxic snakes, against *P kelomohy* in our case is considered inconclusive, and the benefits are unclear. Further immunological and clinical studies are warranted, and preclinical efficacy should be first established before clinical use.

Conclusions

This case report describes the clinical findings associated with a bite from *P kelomohy*, a novel hematotoxic snake species in the genus *Protobothrops*. Envenomation by this snake causes early severe local and systemic complications. The effect of polyvalent antivenom against this snake venom was considered inconclusive. Supportive treatment, adequate resuscitation, and serial clinical and laboratory monitoring are essential to prevent severe clinical complications and mortality. Intracompartmental pressure monitoring is mandatory for proper diagnosis and management guidance of compartment syndrome.

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