Case Report: *Bothrops lanceolatus* Snakebite Surgical Management—Relevance of Fasciotomy

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Abstract. *Bothrops lanceolatus* is an endemic *Crotalidae* species in Martinique, where approximately 30 cases of envenoming are managed yearly. Envenoming characteristics from *Bothrops* species include local tissue damage, systemic bleeding, and hemodynamic alterations. We hereby report a case of severe envenomation following *B. lanceolatus* snakebite to the right calf. Severe local manifestations developed progressively up to the lower limb despite adequate antivenom therapy. Systemic manifestations of venom also occurred, resulting in intensive care therapy. Surgery exploration revealed soft tissue necrosis, friability of the deep fascia, and myonecrosis. The patient needed multiple debridement procedures and fasciotomy of all leg compartments and anterior compartment of the thigh. Diagnosis of necrotizing fasciitis was confirmed by positive *Aeromonas hydrophila* blood cultures. This clinical case illustrates that major soft tissue infection, including necrotizing fasciitis may occur after snakebite. Abnormal coagulation tests should not delay surgical management, as severe envenoming is a life-threatening condition.

INTRODUCTION

Bothrops lanceolatus is a snake, member of the *Crotalidae* family, and is endemic to the island of Martinique (French Caribbean), where approximately 30 cases of envenoming are managed yearly.¹ Although rare, envenoming by *B. lanceolatus* is a serious medical emergency due to major toxic activities of venom mixture. Snakebite by *Bothrops* species typically induces local tissue damage, systemic bleeding, and hemodynamic alterations.^{1,2} By contrast to other *Bothrops* species, the unique systemic effect of *B. lanceolatus* envenoming is multiple systemic thrombosis, which in absence of antivenom administration, leads to cerebral, pulmonary, or myocardial infarctions, occurring in the first 48 hours.³ Although antivenom administration can significantly decrease systemic toxic effects of *Bothrops* venom, it is largely ineffective in preventing tissue destruction and secondary wound infections. We hereby report a clinical case of severe *B. lanceolatus* envenoming with major soft tissue damage and wound infection such as necrotizing fasciitis. We further analyze some scientific literature review pertaining to soft tissue damage related to snakebites of *Bothrops* species and provide rationale for surgical treatment.

CLINICAL CASE

A 42-year-old healthy woman was bitten by a *B. lanceolatus* snake to the right calf while hiking (Figure 1). The geographically remote hiking area was not directly accessible to emergency medical services and the victim had to walk 15 minutes before being transferred to the University Hospital of Martinique. In application of the World Health Organization's recommendations for snakebite, tourniquet was not applied during initial care. The clinical aspect of the snakebite site displayed punctiform tissue perforation, suggesting a double bite. No bleeding was present.

The victim arrived at the emergency room (ER) 3 hours after the bite. The patient had no systemic signs of envenoming, whereas local effects had already rapidly extended leading to major local edema. Envenoming was considered as severe and the patient immediately received Bothrofa v2 antivenom 3 hours after the bite. Antivenom was administered intravenously at the dose of 30 mL/3 hours according to the envenoming emergent management protocol applied at the CHU Martinique (Figure 2). Prophylactic antibiotic treatment was also administered for 48 hours (cefotaxime 2 g/day, metronidazole 500 mg × 3/day, and gentamicin 5 mg/kg/day). Despite adequate antivenom therapy, edema extended progressively to the entire lower limb. Twelve hours after ER admission, the patient had violent headaches and lymphangitis worsened to the genital organs and up to the umbilicus (Figure 3). Bothrofa v2 antivenom was again administered intravenously at the dose of 30 mL/3 hours twice, leading to an overall cumulative accumulating dose of 90 mL since patient admission. Orotracheal intubation and mechanical ventilation were performed as the patient's condition deteriorated,

FIGURE 1. *Bothrops lanceolatus* ("Fer-de-Lance"). This figure appears in color at www.ajtmh.org.

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Updated severity score after *Bothrops lanceolatus* bite (evidence of fang marks) and subsequent doses of Bothropfav® antivenom serum to be infused.

Grade	Severity ^a	Symptoms	Dose of antivenom ^b
1	Minor	No swelling No pain No general signs	None
2	Moderate	Local swelling confined to 2 segments of the bitten limb Moderate pain No general signs	40 mL
3	Severe	Regional oedema: extension of swelling beyond 2 segments Persistent and resistant pain to analgesics No general signs	60 mL
4	Major	Swelling spreading to the trunk General signs (vomiting, headache, abdominal or chest pain) Hypotension Isolated thrombocytopenia Disseminated intravascular coagulation	80 mL

^a Severity is defined by at least one confirmed item.

^b To be given by intravenous infusion or by electrical syringe, diluted in isotonic saline with a flow at about 10 to 20 mL/h. Potential allergic reaction should be considered in all patients.

FIGURE 2. Envenoming emergent management protocol for patients suspected of envenomation by *Bothrops lanceolatus* (Intensive and Emergency Care Department [pole Réanimation Anesthésie SAMU, SMUR, Urgences (RASSUR)]—University Hospital of Martinique).

including a brief episode of bradycardia, rapid breathing to compensate a metabolic acidosis, encephalopathy, and pain in the entire mowed limb resistant to painkillers. Transthoracic echocardiography and brain computed tomography were normal. Intensive care unit physicians retained the diagnosis of septic shock based on the following parameters: tachycardia, systolic blood pressure below 100 mm Hg despite adequate fluid resuscitation, altered mental status, need for ventilation support, increased leukocyte count $> 12 \times 10^9/L$, and evidence of disseminated intravascular coagulation (DIC) (platelets $< 100 \times 10^9/L$, prothrombin time 40%, and fibrinogen 2.12 g/L).

Despite mild deterioration of coagulation tests, surgery was performed 24 hours after ER admission in agreement with intensive care unit physicians. Surgical procedures consisted in debridement and washing as well as fasciotomy of all leg compartments and anterior compartment of the thigh.

Pressures in the leg and in anterior thigh compartments were lower than diastolic blood pressure + 25 mmHg. However, we observed and debrided muscular necrosis of the lateral border of the lateral gastrocnemius, located next to the bite area, through the muscle fascia (Figure 3A). Fasciotomy of all leg compartments were performed through a single lateral incision involving debridement of the bite site, through an anterolateral approach for the thigh (Figure 4). Drains were inserted with a slope from proximal to distal. The patient did not receive application of split thickness skin graft, pedicled flaps, or hyperbaric oxygen therapy.

Histological analysis of muscular debridement fragments found inflammatory tissue rich in neutrophils with necrotic muscle fibers and thrombotic vessels suggestive of DIC. Samples from subcutaneous tissue confirmed dermo-hypodermatitis and necrotizing fasciitis. Blood culture was positive for *Aeromonas hydrophila*, which was treated with

FIGURE 3. Graphic (A) and images (B and C) showing the extension of the lymphedema (dermographism in red dotted line) compared with the bite (red star) at day 1. This figure appears in color at www.ajtmh.org.

FIGURE 4. (A) Subfascial necrotizing myositis of the lateral compartment. (B) Fasciotomy of the four compartments by lateral approach. (C) Fasciotomy of the anterior compartments of the thigh by anterolateral approach. This figure appears in color at www.ajtmh.org.

intravenous ceftazidime 6 g/day for 15 days, starting 2 days after the end of initial prophylactic antibiotic treatment. Because of persistent exudate in drainage, a second surgical procedure was performed 48 hours later allowing for further debridement on the thigh and the leg. No extension of the muscular necrosis was found during this procedure. Delay in healing at the bite site led to necessary mechanical debridement and daily dressing (Figure 5).

Following curative antibiotic treatment and dressings, the patient's wound totally healed in 29 days. Drain sites were left to heal spontaneously, with total healing occurring in 26 days.

DISCUSSION

Bothrops lanceolatus, known as Fer-de-lance is endemic to the island of Martinique.¹ Without adequate antivenom treatment, *B. lanceolatus* envenoming is characterized by local tissue damage and delayed multifocal systemic thrombotic occlusions causing cerebral, myocardial, and pulmonary infarctions.¹⁻³ *Bothrops lanceolatus* venom contains five types of toxins, which belong to the families of zinc-dependent snake venom metalloproteinases (SVMPs), snake venom

serine proteinases, acidic phospholipases A2 (PLA2), L-amino acid oxidases, and a specific C-type lectin-like protein.⁴⁻⁷ Snake venom metalloproteinases, which induced both local hemorrhage and edema formation, are the most abundant components of *B. lanceolatus* venom.⁴⁻⁷ Myotoxic PLA2s are however less present in *B. lanceolatus* venom mixture.⁷

In line with this proteomic profile, *B. lanceolatus* venom induces prominent hemorrhage, whereas PLA2-induced myotoxic activity is relatively weak especially compared with other *Bothrops* species.⁸ In addition, *B. lanceolatus* venom is devoid of coagulant and defibrinogenating activities.⁴⁻⁷ Although *B. lanceolatus* venom displays thrombin-like activity, mechanisms of the predominant thrombotic profile have not yet been elucidated. Proposed mechanisms of local thrombosis phenomena include direct vascular endothelium injury by venom toxins and vascular endothelial cell activation related to inflammatory processes.^{1,2,9} Activation of vascular endothelial cells by *B. lanceolatus* venom is supported by studies showing increased production of inflammatory cytokines, chemokines as well as adhesion molecules and tissue factor expression.^{2,9} Overall, the toxicological pattern of *B. lanceolatus* contrasts with the activity profile described for venoms of other *Bothrops* species, which typically induce a bleeding diathesis and exert strong PLA2-induced myotoxic effects.

Consistent with the toxicological activity profile of *B. lanceolatus* venom, our patient presented with rapidly extensive tissue damage and minor biological changes in blood coagulation tests, suggesting no consumptive coagulopathy. Devastating soft tissue injury may be related to SVMPs, which are known to induce cutaneous and dermal lesions, edema and inflammation, endothelium damage as well as destruction of components of the extracellular matrix and basement membrane of capillaries.¹⁻⁶ Increased vascular permeability at the venom injection site can generate large displacement of fluid from the vascular compartment to the interstitial space contributing to hypovolemia and compartmental syndrome in the most severe cases.^{1,10} Phospholipases A2s activity of *B. lanceolatus* venom can potentiate SVMP-induced soft tissue damage as well as directly induce myonecrosis.⁶

FIGURE 5. Delayed healing by local collagen fibrosis near the debridement zone of the bite (day 8). This figure appears in color at www.ajtmh.org.

Soft tissue infections are well-known complications of *Bothrops* species snakebite.¹⁰ Although compartment syndrome is a rare event in snakebite envenoming, wound infections are facilitated by tissue damage resulting from venom toxins. Inoculation of gram-negative rods (*Morganella morganii*, *Proteus rettgeri*, *Klebsiella* spp., *Enterobacter* spp., and *A. hydrophila*) present in the mouth, fangs, and venom of the snake may be responsible for cellulitis and necrotizing fasciitis.^{10,11} In our patient, necrotizing fasciitis was suspected as extensive local tissue destruction progressed and septic shock developed leading to multiple organ failure, with a positive blood culture for *A. hydrophila*. The life-threatening condition of our patient was considered a true surgical emergency requiring debridement and fasciotomy, broad-spectrum antibiotics, and intensive unit care. Although concerns about amputation came up during our multidisciplinary consultation meeting, such devastating surgery was not performed as edema extended up to the pelvis with no surgical limit and because no clear conclusion on the benefits of this radical surgery could be drawn from available scientific and medical literature.¹²

CONCLUSION

Although proper compartmental syndrome is uncommon, *B. lanceolatus* envenoming can induce neutrophilic dermohypodermatitis, necrotizing fasciitis, and muscular necrosis near the snakebite site. Pathophysiology of the venom, mediated by the action of metalloproteinases and other proteinases, provides insights on how the fascia's mechanical barrier can be crossed. Physicians should be alert to worsening wound condition after a snakebite, and surgical intervention should be performed for established necrotizing fasciitis with empirical use of third-generation cephalosporin and intensive care unit management. Local fasciotomies should be performed systematically to diminish inoculum and perform a debridement of necrotic muscles. An abnormal coagulation profile should not delay surgery as *B. lanceolatus* envenoming is a life-threatening condition.

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