



A rare consequence of snakebite: A case report and literature review

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ARTICLE INFO

Keywords:

Snakebite

Compartment syndrome

Fasciotomy

Case report

ABSTRACT

Snakebites can have a diverse array of symptoms, manifesting both locally and systemically. Local symptoms include mainly swelling and pain. Rarely some patients can develop compartment syndrome. The symptoms of a snakebite can mimic those of compartment, potentially causing a delay diagnosis and treatment which can lead to devastating and a long-lasting disability.

We present a case of an eight-year-old female who presented with systemic envenomation after a snakebite to her left lower leg. Upon arrival, she received supportive care, including antivenom, and demonstrated a good systemic response. However, her leg swelling and pain gradually worsened. She was examined daily by orthopedic surgeons. Clinical examinations initially showed no signs of compartment syndrome until 68 h after admission, when a passive stretch test became positive, and intra-compartmental pressure was found to be elevated. The patient was promptly taken to the operating room for compartment release. The muscles showed no ischemia and two weeks after the release primary closure was done. This case highlights the importance of clinician vigilance and awareness of the potential for delayed onset of compartment syndrome following a snakebite. Our patient was diagnosed and treated in a timely manner, resulting in complete recovery without permanent disability.

Introduction

Snakebites are infrequent in Israel, with an annual incidence of 200 cases. The predominant venomous snake in Israel is *Daboia (Vipera) palaestinae*, which is responsible for the majority of snakebite incidents [1–3]. Snakebites can induce a diverse array of symptoms, manifesting both locally and systemically. While antivenom demonstrates efficacy in addressing systemic envenomation, its effectiveness appears comparatively diminished in local contexts. Local manifestations of snakebites include pain, swelling, particularly exacerbating when linked with skin and soft tissue necrosis [4,5]. Compartment syndrome has been reported in the literature, however most reports are of cases that received delayed care and antivenom [6]. In this report we present a case of a patient that developed a delayed compartment syndrome, despite prompt antivenom administration.

Case presentation

An eight-year-old healthy female patient was hospitalized after she suffered a snakebite to the anterior aspect of her left lower leg,

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Fig. 1. Day of admission, bite marks with soft tissue hematoma and swelling.

Table 1
Laboratory results.

Hemoglobin level of	16.20 g/dl
White blood cells	20,500 cells/ μ l
Platelets	623,000 cells/ μ l
Glucose	150 mg/dl
Creatinine	0.69 mg/dl
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Sodium	140.2 mmol/l
Potassium	3.04 mmol/l
C-reactive protein	<1.00 mg/dl
pH-venous	7.306
HCO ₃ -bicarbonate	18.90 mmol/l
PO ₂	40.50 mm Hg
pCo ₂	18.90 mmol/l
Lactate-whole blood	3.82 mmol/l
Acid base excess	−6.80 mmol/l
PT-seconds	12.8
PT percentage	83 %
APTT	27
APTT-ratio	0.88
PT-INR	1.1
Fibrinogen – Calculated	289
D-Dimer	5370 mg/l

approximately 4 cm proximal to the ankle joint (Fig. 1). The snake was identified later as a rattlesnake of the viper family (*Daboia palaestinae*) – the most common venomous snake in Israel.

Upon hospital arrival, approximately 30 min after she was bitten, her Glasgow coma scale was 15, oxygen saturation was 100 %, respiration was 26 breaths per minute, heart rate was 142 beats per minute, and blood pressure was 111/50 mm Hg. The patient had already vomited several times prior to her arrival. Her physical exam showed a double penetrating pin-point wound, matching a snakebite mark. There was local swelling around the wound, but no swelling of the foot leg or thigh. There were no signs of compartment or any neurological or vascular defect. Within 18 min of her arrival, the patient's blood pressure dropped to 80/44 mm Hg, while her heart rate remained approximately 140–150 beats per minute. Lab results were within normal range (Table 1). The patient was treated immediately with 5 ampules of antivenom, as well as intravenous fluids. Upon treatment, her blood pressure improved to 110/50 mm Hg, and her heart rate was 136 beats per minute. Upon stabilization, she was hospitalized in the pediatric intensive care unit; there was no change in patient complaints of pain and her VAS (visual analog score) was 4.

In intensive care, the patient showed no sign of shock. However, on day 2, the swelling of the left leg and foot had gradually increased, reaching up to the thigh. Additionally, several bullae with serous and hemorrhagic fluids appeared around the ankle (Fig. 2). She complained of pain, which was managed well with pain medication. Her physical examination, performed by an orthopedic surgeon, demonstrated no signs of compartment. Lab tests showed coagulation abnormalities (Table 2). There were no clinical signs of bleeding. At approximately 64 h following hospitalization, the patient developed increased pain. Her examination was positive for signs of compartment syndrome, including passive stretch. Compartment pressure measurement revealed a pressure of 90 mm Hg in the anterior compartment and 70 mm Hg in the posterior. The patient was taken for emergency surgery, and compartment release of the leg and foot was carried out (Fig. 3). At surgery, muscle bulging was observed without signs of ischemia. Prior to surgical intervention, coagulation parameters were normal, as seen in Table 3. The patient required no further release during her hospital stay. She was treated locally with bandage change and closure with vacuum application. When the swelling subsided, 2 weeks after the compartment release, primary skin closure was performed, with good wound adaption. Upon physical examination 2 months post-closure, the patient appeared to be pain free; she ambulated freely, and her wounds healed well (Figs. 4–6). She had no limitation in her lower limb joints or any vascular or neurological defect.

Discussion

Venomous snakebites possess neurotoxic, hemotoxic, and cytotoxic properties. They contain enzymes that cause cell apoptosis, lysis, capillary leakage and coagulopathy [5,6]. Most symptoms of snakebite typically develop within 12 h [6,7]. However, as seen in the case presented, some symptoms can worsen or appear days later.



Fig. 2. 2nd day of admission, increased swelling and skin blisters.

Table 2
Coagulation Factors Tests.

PT-sec	16.5
PT%	58.0
APTT-sec	30/4
APTT-ratio	0.98
PT-INR	1.4
Calculated fibrinogen	557 mg/dl

Antivenom comprises immunoglobulins which selectively bind to, and neutralize, venom toxins. While its efficacy in addressing local symptoms remains debatable, the World Health Organization (WHO) guidelines advocate antivenom administration in instances exhibiting systemic envenomation signs, including neurotoxic, hemotoxic, or cardiovascular manifestations, as well as severe local symptoms, such as a severe swelling involving more than half of the limb, rapid extension of swelling or lymph node involvement [8].

A study investigating the epidemiology of compartment syndrome following snakebites in North America revealed a low incidence, occurring in fewer than 1 % of all reported cases. Furthermore, the majority of fasciotomies performed were conducted without measuring intercompartmental pressures [9]. The signs and symptoms of a snakebite can mimic or mask signs of compartment syndrome, leading to overdiagnosis or a missed diagnosis [8–10], and thus we recommend the use of intercompartment measurements in the presence of compartment syndrome symptoms for an accurate diagnosis.

For diagnosis, in addition to signs and symptoms of compartment, the WHO recommends performing ICP measurement; a measurement of 40 mm Hg or above should be surgically released [8]. Conversely, some studies recommend performing a compartment release when intercompartmental pressure is >30 mm Hg and progressing, following the administration of all supportive measures and antivenom [10]. In a study by Gold et al., acute compartment syndrome due to a snakebite was managed successfully by the administration of antivenom and mannitol; however the reported compartment pressure in these cases did not exceed 30–32 mm Hg [11]. In another study by Turkmen et al., 37 out of 40 patients diagnosed with compartment-like symptoms after a snakebite, were managed successfully with antivenom and mannitol despite an intercompartment pressure exceeding 55 mm Hg. The three patients who did not respond had intercompartmental pressure >65 mm Hg [10]. The optimal threshold for surgical intervention in cases of compartment syndrome has been widely studied, yet remains unresolved. Clinicians predominantly rely on the delta pressure (ΔP) - calculated as the difference between diastolic blood pressure and intracompartmental pressure - as a standard measure when evaluating compartment pressures. A ΔP equal to or <30 mm Hg delineates acute compartment syndrome (ACS) [12]. Many methods of treatment for compartment syndrome due to a snakebite have been suggested; however, the administration of antivenom initially remains the most acceptable [8]. Each country has its own protocol for treating snakebite, considering the local snake species and antivenom manufacturer. Nonetheless, there is consensus that, in the case of compartment syndrome, the earlier the antivenom is administered, the better [13]. A review of 99 articles by Cumpston on Crotalinae snakebites concluded that the use of Fab antivenin resulted in decreased compartment pressure and improved tissue perfusion. Moreover, he found that fasciotomy was not beneficial due to exacerbating the effect of tissue necrosis [15].

In our experience, although compartment is rare after a snakebite. However, when the ΔP is <30, compartment release is recommended if antivenom was already administered. In our case, the patient presented with hypotensive shock due to a common venomous snakebite - *Dobia palaestina*. Approximately 30 min after the bite, despite a good systemic response to antivenom treatment and a rather quick stabilization of her vital signs, the patient's local symptoms continued to evolve slowly and she eventually developed compartment syndrome. Late development of compartment syndrome due to a snakebite after early antivenom administration is yet to be described in the literature. Cawrse et al. described a case of a patient that developed compartment syndrome 3 days after a snakebite. Upon diagnosis, the patient underwent fasciotomy and received antivenom. However, it is worth noting that that case the patient did not receive antivenom at reception [16]. In our experience in pediatric patients and in patients with systemic signs of envenomation or severe local signs on reception, need a multidisciplinary approach and a prolonged observation. An internationally accepted protocol is yet to be adopted, however for children with mild symptoms, some authors suggest an observation ranging from 6



Fig. 3. Day 1 after compartment release.

Table 3
Clotting factors function.

PT-sec	13.6
PT%	76
APTT-sec	32.2
APTT-ratio	1.04
PT-INR	1.2
Calculated fibrinogen-mg/dl	623



Figs. 4–6. Healed wounds after primary closure.



Figs. 4–6. (continued).



Figs. 4–6. (continued).

hours [3], to 8 hours [17], or even 72 hours [18]. We follow uncomplicated pediatric patients for at least 48 h. In cases with swelling that has not resolved within 48 h, a prolonged follow-up and differential diagnosis is recommended.

Conclusion

Compartment syndrome due to a snakebite can develop several hours or days following a snakebite. Extended follow up is recommended for patients with systematic involvement or local symptoms necessitating antivenom treatment. The exact time window of follow-up needs to be determined upon further research; however, we recommend 48 h follow-up for non-complicated cases, and 72 h in complicated cases. The caregiver should use objective measures, such as compartment syndrome pressure measurement, to make an accurate diagnosis. In addition, the caregivers should be vigilant to the possibility of compartment syndrome.

CRedit authorship contribution statement

Fadi Aboud: Investigation, Writing – original draft, Writing – review & editing. **Micheal Assaf:** Conceptualization, Formal analysis, Supervision. **Haim Shtarker:** Validation, Writing – review & editing.

Declaration of competing interest

We declare that we have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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