

Copperhead Envenomation Resulting in a Rare Case of Hand Compartment Syndrome and Subsequent Fasciotomy

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Summary: Copperhead bites account for nearly 40% of all snakebites in the United States. Although common, these bites are rarely severe, and most are treated with supportive care and antivenom. We describe the first reported case of a copperhead envenomation resulting in a hand compartment syndrome with measured elevated compartment pressures that necessitated fasciotomy of the hand. Our case underscores the importance of vigilance in the diagnosis and management of copperhead envenomation. (*Plast Reconstr Surg Glob Open* 2015;3:e396; doi: 10.1097/GOX.0000000000000367; Published online 11 May 2015.)

Pit viper (rattlesnake, cottonmouth, and copperhead) envenomation results in local tissue injury with pain, tenderness, edema, induration, and ecchymosis. Although compartment syndrome is a common concern, true compartment syndrome is actually rare.¹

Copperhead (*Agkistrodon contortrix*) snakes are responsible for over 40% of all US pit viper envenomations and tend to have less severe tissue injury.² There is only one reported case of objectively measured compartment syndrome in copperhead envenomation. This compartment syndrome resolved with antivenom therapy alone and never required operative intervention.³ We report the first case of a copperhead envenomation patient with definitively diagnosed compartment syndrome and failed medical therapy requiring fasciotomy.

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CASE REPORT

A 9-year-old boy with a history of autism was playing in the garden when a snake bit him on the thenar eminence of the left hand. He presented to a local emergency department 1.5 hours later, and his parents brought the carcass of the offending copperhead snake. The patient's soft tissue response worsened, he was transferred to a tertiary care center emergency department, and the Poison Center was notified.

Upon arrival, the patient had ecchymosis over the thenar eminence with significant edema of the finger and hands, and swelling of the arm 1 cm distal to the antecubital fossa. Six vials of Crofab antivenom (Crotalidae polyvalent immune fab; BTG International, West Conshohocken, Pa.) were administered on arrival, and his hand was elevated with initial moderate improvement. Overnight, the hand swelling worsened, and he was administered another 4 vials of antivenom at 6:30 AM. Despite this therapy, his symptoms progressed, and he received another 4 vials at 12:30 PM and 2 more vials at 15:30 PM.

As he was not adequately responding to aggressive medical therapy, plastic surgery was consulted to assess the need for surgical intervention. On evaluation, the patient demonstrated dense swelling of the hand centered at the thenar eminence, with arm swelling to the mid humerus. Examination was limited by patient

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cooperation, but was concerning for a compartment syndrome because of the severity of swelling and tenderness when compared with typical copperhead envenomation patients. Procedural sedation was performed, and compartment pressures were measured using a Stryker intracompartmental pressure monitor (Kalamazoo, Mich.). The thenar, palmar, index/long dorsal interosseous, and volar forearm compartments measured 56, 55, 32, and 15 mm Hg, respectively. The patient received 4 more vials of antivenom en route to the operating room, where repeated measurements of the thenar and dorsal intracompartmental pressures were 55 and 33 mm Hg. A 9-compartment hand fasciotomy was performed. Upon compartment opening, all intrinsic muscles of the hand initially appeared grey but gradually returned to a healthy pink-red hue. The patient had an uneventful subsequent postoperative course, with no wound healing complications or lasting functional deficits at 2-week follow-up.

DISCUSSION

The management of pit viper envenomation includes supportive care, antivenom administration as needed, and serial assessment for progression of the envenomation syndrome.⁴ With this approach, compartment syndrome and consequent fasciotomy are rare and not previously reported in copperhead envenomation specifically.^{1,3} Both snake-related and patient-related factors are potential causes of this patient's unusual presentation. The culprit snake was a full-grown adult copperhead, which can produce a larger volume of venom and consequently a more severe clinical course.⁵ Additionally, children may be at higher risk for a more severe envenomation syndrome, as the same amount of venom distributes in a smaller volume in children.⁶ They also have smaller compartments, which may increase the risk of compartment syndrome for any given venom load. In fact, the only reported case in the medical literature of documented elevated compartment pressures from copperhead envenomation was in a 17-month-old patient.⁴

When considering compartment syndrome in a pit viper envenomation patient, it is important to recognize that the prevalence is very low. In one study of rattlesnake envenomation, only 3.4% required fasciotomy.¹ As copperhead envenomation tends to be less severe, the prevalence of compartment syndrome in this population is so low as to be unknown. Unfortunately, local tissue findings in pit viper envenomation often mimic compartment syndrome; and the classic findings of firm compartments, pain out of proportion to injury, or pain with passive stretch are overly sensitive in making the diagnosis. Current guidelines recommend definitively diagnosing compartment syndrome with

objective pressure measurements rather than relying solely on physical examination.⁷ Despite its rarity, the correct diagnosis was made in this case because of the recognition of increased risk in a child, the severity of the local symptoms when compared with other copperhead envenomations, the progression of symptoms despite therapy, and ultimately the measurement of intracompartmental pressures.

Historically, both prophylactic fasciotomy and fasciotomy based on physical examination alone have been performed in pit viper envenomation because of concerns for compartment syndrome. However, this aggressive approach leads to unnecessary surgery and subsequent morbidity. Modern guidelines recommend against this approach and provide a simple algorithm to the diagnosis and treatment of pit viper compartment syndrome.⁷ These recommendations differ from the diagnosis and treatment of other compartment syndromes in important ways.

Fasciotomy is the treatment for compartment syndrome from trauma or similar causes, but its effectiveness in pit viper envenomation is uncertain. In animal models, both antivenom and fasciotomy have been noted to lower intracompartmental pressures, but fasciotomy resulted in worse myonecrosis when compared with antivenom alone.^{8,9} In humans, antivenom lowers intracompartmental pressures and is now considered first-line therapy with fasciotomy being reserved only for those patients that fail medical therapy.^{3,7,10} The current algorithm recommends administering antivenom in compartment syndrome while planning potential operative intervention and repeating pressure measurements just before surgical incision, as was done in this case.⁷ This approach maximizes necessary fasciotomies and limits unnecessary ones.

CONCLUSIONS

Copperhead snakes are the most frequent envenomating pit viper species in the United States. Severe cases of copperhead envenomation concerning for compartment syndrome require the expertise of a physician experienced in their treatment and a surgeon both skilled in fasciotomies and aware of how these compartment syndromes differ from others. An algorithmic approach to the management, such as the one we followed, is useful to ensure unnecessary surgeries are avoided, and necessary fasciotomies are not delayed.

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