Severe rapid-onset paralysis in a part-time soldier

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Introduction

We report a case of severe rapid-onset paralysis in a 28-year-old previously healthy man, necessitating intubation and mechanical ventilation, after a presumed bite or sting. Despite no other systemic manifestations of envenoming, the paralysis rapidly responded to polyvalent snake antivenom. The rapidity and severity of clinical effects make this case most concerning. We outline a differential diagnosis of acute paralysis and comment on issues relating to the management of the envenomed patient.

Clinical record

A previously well 28-year-old man was participating in army-reserve field training at Murray Bridge, South Australia (latitude, 35×07'S; longitude, 139×21'E) in December 2004. While crawling through bush on an attack exercise in mid-afternoon, he felt something sharp on his right arm. He was wearing gloves and a long-sleeved shirt buttoned at the wrists. So as not to divert his gaze from the "enemy", he brushed the sharp object from his arm without looking at it.

Within 5 minutes, he felt paraesthesia in his right arm. He notified his companions, who suspected snake bite and applied a pressure immobilisation bandage. Over the next 10 minutes, he developed paralysis, spreading down the face, then to the neck and chest. He described the sensation of his "face being pulled down". He was unable to control gaze and developed diplopia and difficulty talking, coughing and breathing. His hearing was not affected. Over the ensuing 10 minutes, he lost the ability to move his arms and then his legs.

When the ambulance service arrived, they assessed him as requiring respiratory support and began hand ventilation with a self-inflating bag and mask. The patient remained conscious, and subsequently described his relief with the assisted ventilation. He was rapidly transferred to Murray Bridge Hospital, arriving 60 minutes after the initial "bite" sensation.

The local general practitioner noted on examination that the patient was making minimal respiratory effort, had ocular ptosis, and could make only very slight, non-sustained movements of his limbs. His deep tendon reflexes were not examined. Heart rate was 100 beats per min; blood pressure, 110/70 mmHg; SpO2, 100% (with assisted ventilation and FIO2, 1.0); temperature, 37.2×C; and blood sugar level, 5.5 mmol/L. Pupils were 4 mm in diameter, equal and reacting. He was intubated by the GP (using only intravenous midazolam, 5 mg), but because of some residual weak vocal cord activity, he was then given intravenous suxamethonium (100 mg). Ventilation was begun.

It was noted that he had scratches over his arms and legs, but no obvious fang or puncture sites and no evidence of clinical bleeding. The pressure immobilisation bandage on his right arm was reinforced. A urinary catheter was inserted, and he passed good volumes of clear urine.

Of note, there was no suspicious odour, lacrimation or bronchorrhoea. None of his companions had become unwell, and he had eaten the same food as others. He had no significant past medical history, and denied taking other medications or recreational drugs.

After 10 minutes of mechanical ventilation, he regained some slight non-sustained movement of his limbs. This would have coincided with waning of the suxamethonium effect.

Urine was tested with the Snake Venom Detection Kit (Commonwealth Serum Laboratories [CSL], Melbourne, VIC), which gave a weak positive reaction to brown snake venom within 10 minutes of incubation. Whole-blood clotting time was 4.5 minutes (reference range, < 10 minutes).

Given the strong suspicion of envenoming as a cause of the paralysis, and no other obvious cause, the patient was given one ampoule of CSL Polyvalent Snake Antivenom intravenously. Within 10 minutes of administration, he was able to make non-sustained movements, lifting his arms and legs off the bed. Deep tendon reflexes were present with down-going plantar reflexes. Given this apparent response, another ampoule of antivenom was administered, after which his movements and respiratory effort became more sustained and purposeful. He was sedated with a propofol infusion (200 mg/h intravenously), and transferred by helicopter to a tertiary hospital.

Results of laboratory investigations on arrival are shown in Table 1. He remained intubated for 10

hours, while having repeated clinical and biochemical assessments. During this time, he retained satisfactory muscle strength and was extubated uneventfully. The only biochemical abnormality was serum creatine kinase level, which peaked at 2375 U/L (RR, 0–270 U/L) within 24 hours, and subsequently fell. He was observed in hospital for a further 48 hours, where he remained well and was able to describe the evolution of his paralysis. He was warned of serum sickness and given prophylactic oral prednisolone before discharge home.

In the absence of any other cause for his paralysis and the apparent response to antivenom, we considered the most likely diagnosis was snake bite.

Discussion

We believe this case may represent envenoming by a snake, but it is not typical of envenoming by any elapid species known to inhabit the region around Murray Bridge in South Australia. Although no snake was seen, there is little other explanation for such rapid onset of paralysis, which decreased after treatment with polyvalent snake antivenom.

Features suggesting that the paralysis was due to envenoming include:

- classic descending paralysis (ie, descending cranial nerve involvement which progressed to limb and chest weakness);
- rapid improvement in muscle power after administration of polyvalent antivenom; and
- absence of any other apparent explanation for this constellation of features.

However, a number of features of this case might not seem typical of snake envenoming:

It is uncommon for a bite by an Australian snake to produce paralysis within 1 hour, and progression to full respiratory paralysis usually takes several hours. In our case, the patient described progression from an apparent bite to severe paralysis in around 30 minutes.

- The patient did not see a snake. However, many Australian elapids have small, fine fangs that can cause only minor discomfort, and the snake can rapidly leave the scene.
- There were no obvious puncture or fang marks. However, small fine fangs can cause scratches rather than discrete fang marks.
- The patient wore long sleeves buttoned at the wrist and gloves, rendering fang penetration much less likely.

The only snake known to cause rapidly reversible paralysis is the death adder. These are not known to exist usually around Murray Bridge.

Some other causes of rapid onset paralysis are shown in Table 2. Despite searching for other causes in our patient, none proved tenable, and no other envenoming seemed credible. Spiders, scorpions, and centipedes can bite or sting but do not cause paralysis.[1,2] Some marine animals can cause rapid paralysis, but the area where the incident occurred was in an arid inland region.

Assuming a snake neurotoxin was responsible, the rapidity of both the paralysis and the improvement after antivenom administration suggests that the toxin blocked either axonal nerve conduction (like tetrodotoxin) or neuromuscular transmission at the post-synaptic membrane. A pre-synaptic neurotoxin would be much less likely, as these toxins generally have a latency period of at least 60 minutes and a much slower response to antivenom.[3]

Most snake bites in Australia present with a spectrum of coagulopathy, rhabdomyolysis, neurotoxicity and renal impairment. However, our patient presented with paralysis alone, and no evidence of coagulopathy or renal damage. Although there was a rise in serum creatine kinase level to 2375 U/L — about 10 times the upper limit of normal — snake-bite myolysis is usually associated with far higher levels, and this level might be explained purely by strenuous physical activity.

Results of laboratory investigations on arrival at a tertiary hospital

- International normalised ratio, 1.1 (RR, 0.8–1.2)
- Activated partial thromboplastin time, 28 s (RR, 24–37 s)
- Fibrinogen, 2.4 g/L (RR, 1.5–4.0 g/L)
- D-dimer, 0.40 mg/L (RR < 0.5 mg/L))
- Creatine kinase, 2293U/L (RR, 0–270U/L)
- White cell count, 8.2 109/L (RR, 4.0–11.0 109/L)
- Lymphocyte count, 2.1 109/L (RR, 1.0–3.5 109/L)
- Serum electrolytes, renal function, liver function, within RR
- Drug screen, none detected
- Cerebrospinal fluid
  - No polymorphonuclear, mononuclear or red blood cells
  - Protein, 0.40 g/L (RR, 0.10–0.65 g/L)
  - Glucose, 2.5 mmol/L
  - No organisms on culture
  - Herpes simplex virus and enterovirus not detected

RR = reference range. ◆

Table 1

Furthermore, the recorded creatine kinase level was highest on Day 1, and declined serially to normal over 3 days. However, we cannot absolutely exclude venom-mediated myolysis, particularly as it could be argued that early use of antivenom may have prevented it becoming more severe. Such an argument cannot be applied to coagulopathy, which is generally rapid in onset following envenoming.

What type of snake could have caused this pattern of envenoming? This presentation is typical of a death adder (Acanthophis antarcticus) bite. These are relatively uncommon in Australia. Typical features are a minor to moderate "sting", local discomfort, neurotoxicity presenting as flaccid paralysis, absence of coagulopathy and rhabdomyolysis, and a rapid complete response to antivenom (CSL Polyvalent or CSL Death Adder Monovalent Antivenom).[4,5] This envenoming syndrome closely resembles the case presented. Death adder venom is a post-synaptic neurotoxin, and the resulting paralysis can be temporarily reversed by anticholinesterases such as neostigmine.[6] This was not used in our patient, as polyvalent antivenom was available and rapidly decreased the paralysis.

However, death adders are not known to inhabit the region around Murray Bridge, with museum records locating them 100 km away,[7] separated by natural barriers — the Murray River and Mount Lofty Ranges. But death adders are notoriously elusive, and there may be an undiscovered population inhabiting this region. Jelinek and Wambeek reported a case of death adder envenoming in a region of Perth where death adders have not previously been identified.[8] Snake distribution lists are compiled by museums based on snake capture and positive identification, and hence it is possible that other populations of snakes exist but have not been identified. The published distribution maps should be used as a guide only. Furthermore, several days before this case, Murray Bridge received unseasonable heavy rains causing flooding of the township. The area where the army exercise was held was not directly affected, but the flooding may have displaced an unusual species of snake.

Another possible envenoming could be from the bardick snake (Echiopsis spp.). This is known to inhabit the region around Murray Bridge, but the clinical features of envenoming by this snake are uncertain. Venom analysis suggests it has neurotoxic properties, but the single published case report documents only localised bite effects, with no features of paralysis, myolysis or coagulopathy.[9] Phylogenetic studies have not placed the bardick close to death adders, but rather close to another genus of small terrestrial elapids (Denisonia), which are not known to cause major envenoming.[10]

Other Australian snakes that cause paralysis include tiger snakes, taipans, rough scaled snakes and copperheads.[4] It is unlikely that any of these was responsible, as their venom causes coagulopathy and rhabdomyolysis, and contains pre-synaptic neurotoxins. Brown snakes can cause paralysis, their venom containing both pre- and post-synaptic neurotoxins, but paralysis is rarely seen clinically in humans (in contrast to domestic animals) and then only hours after the bite.[5]

Some other causes of rapid-onset paralysis

- Toxins
  - Tetrodotoxin (blue-ringed octopus, fugu fish ingestion)
  - Conotoxins (cone snails)
  - Holocyclotoxins (paralysis ticks, which produce paralysis in hours to days, rather than minutes)
- Neuromuscular blocking drugs
- Organophosphates
- High spinal cord lesion
- Myasthenia gravis
- Botulism
- Tetanus
- Electrolyte abnormalities
- Acute inflammatory demyelinating polyneuropathy
- Hysterical paralysis ◆

Table 2

The result of the Snake Venom Detection Kit (SVDK) in our patient might superficially be taken as confirmation of a bite by a brown snake, but there are several reasons to suspect this was a false positive result. Firstly, urine is known to give a weak positive result for brown snake venom in the absence of brown snake envenoming. While not documented by CSL, this phenomenon is well known among those who frequently deal with SVDK interpretation — an important reason for not testing urine in clinically well patients, and a powerful argument against using the SVDK as a screen for snake bite. Secondly, our patient had none of the classic features of brown snake bite (coagulopathy, renal damage, non-specific systemic symptoms), but rather features not generally associated with brown snake bite, notably rapid onset paralysis. Thirdly, the test urine was collected soon after the bite, most likely before it could have accumulated significant levels of venom. We therefore do not believe the SVDK urine result was either confirmatory evidence of snake bite, or of the type of snake. It is important to emphasise that the role of the SVDK is not to diagnose whether snake bite has occurred, as this is a clinical decision, but rather to guide which monovalent antivenom to use once envenoming has been diagnosed.

In summary, while we cannot prove that the rapid paralysis in our patient was caused by snake bite, the case highlights the need to consider envenoming in any patient who collapses or has sudden weakness after spending time outdoors. Empirical use of antivenom may be required after due consideration of other causes of acute paralysis.

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