

Hot water immersion as a treatment for stonefish sting: A case report

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Abstract:

The North Borneo state of Sabah is known worldwide for its beautiful islands and dive sites. Local hospitals deal with a number of marine-related injuries, including marine fauna envenomation by Scorpaenidae and Synanceiidae families of fish. We report a case of a tourist who presented with excruciating pain on her right foot after stepping on a stonefish. Despite being given parenteral analgesia and regional anaesthesia, the pain persisted. Her pain improved after she soaked her foot in hot water for about 30 minutes. No further treatment was required. We reviewed the literature comparing this inexpensive mode of treatment with other conventional treatments. We also explored the possibility of using hot water immersion for treatment of envenomation by other types of marine animals.

Introduction

The East Malaysian state of Sabah is a well-known destination for tourists as well as divers because of its beautiful islands and world-renowned dive sites. A significant proportion of the state's population resides along the coastline, which contributes to the high number of sea-related activities and occupation. Therefore, marine fauna-related injuries are often encountered by the local emergency services.

The *Scorpaenidae* and *Synanceiidae* families of venomous sea fish are mainly found in the shallow tropical waters of the Indo-Pacific region.¹ Both families share similar features, and consist of hundreds of species that are divided into three groups based on the structure of their venom organs and toxicity. They are the genera *Pterois* (lionfish) and *Scorpaena* (scorpionfish) of the *Scorpaenidae* family, and *Synanceia* (stonefish) of the *Synanceiidae* family. The venom organs comprise 12 or 13

dorsal, 2 pelvic and 3 anal spines, each covered with an integumentary sheath and a pair of glands that secrete venom along the grooves at the anterolateral region of the spine when mechanical pressure is applied^{1,2}. The *Pterois* has long and thin spines with small venom glands and less potent venom while the *Scorpaena* has shorter and thicker spines with larger glands and more potent venom. Among the three groups, the *Synanceia* genus of fish possesses the most potent, possibly lethal venom.³

The venom of *Scorpaenidae* and *Synanceiidae* fish are heat-labile and has high molecular weight proteins with antigenic properties and enzymes, quite similar to other marine venoms.⁴ The venom is a mixture of proteins, including hyaluronidase which is responsible for connective tissue destruction, and a protein lethal factor that has cytolytic, neurotoxic and hypotensive activity.⁵ The predominant symptom is pain at the affected area, which may range from mild to severe depending on the number and type of stings, species of

fish, amount of venom injected, and age and health status of the victim.² It may radiate to the entire limb and peaks at 60 to 90 minutes, and may last up to 12 hours if left untreated. Victims may also experience pain at regional lymph nodes, local erythema with evidence of sting marks, swelling, oedema, and numbness.⁶ Various systemic manifestations such as nausea, diaphoresis, breathing difficulties, abdominal or chest pain, weakness, delirium, seizures, syncope, arrhythmias and hypotension have been reported.^{2,4}

The venom protein's instability to heat is the basis of the hot water immersion treatment. Heat causes the denaturalisation of the protein that renders the venom inactive. It has been suggested that this form of treatment also modulates pain receptors in the nervous system to reduce of pain.⁷

Case report

A 47-year old lady was brought to the Emergency Department (ED) complaining of severe pain on her right foot after stepping on a stonefish while diving off the coast of Kota Kinabalu. She rated her pain score to be 8/10. She did not complain of any systemic symptoms. She was afebrile, not tachypnoeic, blood pressure 139/87 mmHg and pulse rate 77 beats per minute. On examination of the patient, her right first toe was swollen and red with no obvious puncture wound. There was no foreign body or fish spine seen. The toe was very tender and she complained of pain even on slight movement. Flexion of her ankle was also painful. The erythema extended up to her right calf which was mildly tender. Capillary refill of her distal digits was normal. The rest of the examination was unremarkable with no signs of anaphylaxis.

Initially, 75mg of intramuscular diclofenac was administered. Twenty minutes later, there was no improvement in her pain, and she was given 5mg of intravenous morphine; however, the pain worsened. Regional anaesthesia in the

form of an ankle block of the right foot was applied. Despite this, the pain remained severe.

Subsequently, we soaked the patient's right foot in a metal basin filled with hot water up to the patient's ankle for about 30 minutes. We used the elbow skin test to check the water temperature. The heat was adjusted to the highest temperature that the skin was able to tolerate as suggested in the literature. Hot water was added to the basin every 10 minutes to maintain the temperature. Her pain score reduced to 5/10 at about 15 minutes after the treatment, and to 1/10 an hour later.

A re-examination of the foot showed reduction of swelling and tenderness. Distal capillary refill was immediate and movement of the toe was non-tender. There was also no evidence of scalding or burn from the hot water immersion treatment. She was observed in ED for another two hours. She was then discharged with oral pain analgesia and anti-histamines.

Discussion

The use of heat to treat marine envenomation was first recorded in 1758, when German fishermen applied hot poultice onto sting wounds caused by weever fish.⁸ Heat treatment, therefore, has been used traditionally for centuries to treat fish stings. Heat was administered in the form of hot water, vinegar, stones and even hot urine.⁸ Various methods of hot water therapy have been applied, including hot water immersion in a basin, hot showers and thermal packs.⁷ The current practice is to submerge the affected limb into non-scalding hot water at the temperature of 45°C for 30 to 90 minutes until the pain subsides. It is important that the water temperature is maintained by continuous monitoring and adding hot water. Lau et al found that a thermal isolator (e.g. a portable ice chest) is able to maintain the temperature longer than a plastic sharps bin or a metal basin.⁹ The group recommended the use of aluminum foil or plastic wrap to cover the container, larger volume of water (8 to 10 litres), and a

thermometer to monitor the temperature of water. We utilised a metal basin to treat our patient with hot water immersion therapy and tested the water temperature regularly. We could have regulated the temperature more accurately by using a thermometer.

In cases of *Scorpaenidae* or *Synanceiidae* envenomation, there are no studies done specifically to compare hot water immersion alone to other modes of treatment. Most case studies in the literature report hot water immersion as the initial treatment for this type of marine envenomation, and suggest concomitant use with parenteral analgesia or local anaesthesia to control the pain. A poison centre in San Francisco reported favourable outcome using hot water immersion to treat *Scorpaenidae* stings, with 80% out of the 94% patients that received the treatment experiencing complete pain relief.¹⁰ Two case reports acknowledged the effectiveness of hot water immersion in controlling pain without the use of analgesic drugs, although one case suffered recurrence of pain and acute carpal tunnel syndrome within 24 hours after resolution of pain.^{11,12} A case series by Lee et al reported tissue necrosis in a victim of stonefish sting who did not receive hot water immersion treatment. This is possibly due to the persistence of the active venom in the wound.¹³ The group went on to recommend it as the first line of treatment before supplementing the pain control with additional analgesia. However, a retrospective study of 30 cases of stonefish envenomation in Singapore by Ngo et al observed that most victims required both parenteral analgesia (intramuscular pethidine or diclofenac) and hot water immersion therapy.⁶ Thirty percent of the patients required additional analgesia, and five were warded for wound complications. It is, therefore, difficult to conclude whether the clinical outcomes, the need for additional analgesia and wound complications are related to the use of hot water immersion because most cases used both treatment modalities.

There is an antivenom for stonefish envenomation prepared from equine plasma

that is immunised by the venom.¹⁴ This antivenom is unavailable in our setting, but the literature has suggested that it is rarely needed unless there is persistent pain despite multiple treatments or the presence of systemic features of envenomation.^{11, 12, 13, 14} The stonefish antivenom has been shown to cross-react with scorpionfish venom, suggesting similar biochemical properties of *Scorpaenidae* and *Synanceiidae* venoms.¹⁵ It is perhaps inappropriate to compare hot water immersion to antivenom treatment, because hot water soaks provide symptomatic relief and possibly inactivate the venom locally, thus prevent the spread of the injury; whilst the antivenom is a parenteral medication that inactivates the venom in the systemic circulation. Presently, there are no detailed studies proving the thermo-labile feature of the venom. Thus it can be argued that the diffuse noxious inhibitory control theory of pain, which is when a painful stimulus is inhibited by another, could be responsible for the reduction of the pain of the sting by hot water immersion.¹⁶ Our case, however, seemed to support the idea that the venom protein is denatured by heat treatment, because in spite of using pharmacological treatments, the pain did not resolve until hot water immersion therapy was initiated.

Another issue with the use of hot water immersion therapy is the possibility of enhancing the proliferation of marine organism especially *Vibrio vulnificus*, a type of aquatic bacteria responsible for causing necrotising fasciitis in fish sting victims.¹⁷ The temperature of the water seems to increase the activity and proliferation of the bacteria. Although antibiotic prophylaxis is controversial in the management of stonefish envenomation, antibiotic coverage may be appropriate in stonefish sting victims, especially in areas with high prevalence of vibrio infection. This could explain the reason for prophylactic antibiotic administration in some stonefish envenomation cases.⁶ One study has advocated the use of prophylactic antibiotics to cover for vibrio and other marine organism as puncture sting wounds are at risk of secondary infection.¹³

In this case, however, antibiotic prophylaxis was not prescribed as there were no puncture wound seen and hence, the risk of infection was probably lower. Several antibiotics have been suggested in the literature for *Scorpaenidae* and *Synanceiidae* envenomation including broad-spectrum antibiotics (e.g. amoxicillin-clavulanate, ceftazidime), ciprofloxacin and doxycycline.^{13,17}

Hot water immersion therapy has also been used for several other types of marine envenomation.⁴ Hot water immersion therapy has been assessed and found to be effective in treating puncture-type stings caused by marine vertebrates, and increasingly, for surface-type stings with nematocysts by jellyfish.⁷ Loten et al found that hot water is more effective than ice packs in controlling the pain of bluebottle jellyfish stings, with 87% of patients reporting reduced pain with hot water immersion compared to only 33% who used ice packs.¹⁸ It has also been shown that box jellyfish venom lethality decreases as the water temperature increases above 39°C and with prolonged immersion.¹⁹ Hot water immersion therapy has been recommended for various venomous fish including stingrays, catfish, stonefish, scorpionfish and lionfish, Portuguese Man-Of-War or physalia sp. jellyfish, sea urchins and, to some extent, box jellyfish and Irukandji jellyfish^{1,2,4}.

Conclusion

In the event of envenomation by *Scorpaenidae* and *Synanceiidae* family of venomous fish, non-scalding hot water immersion at 45°C up to 30 minutes appears to be the appropriate initial treatment. Victims should be closely monitored and supplemented with extra analgesia if needed. Antibiotic coverage should be considered for the patients receiving this treatment especially those with deep puncture wounds and are at risk of developing vibrio necrotising fasciitis. This method shows favourable results in the literature, not only in stonefish stings, but also other venomous fish

spine and invertebrate stings. Therefore, this easy and inexpensive mode of treatment should be considered for the treatment of marine envenomation.

Conflict of interest statement

We declare that we do not have any conflict of interest. This paper was presented as a poster at the 3rd International Conference on Rural Medicine 2011 (ICORM) held in Kota Kinabalu, Sabah on 22-24 November 2011.

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How does this paper make a difference to General Practice?

1. It is understood that most of the patients on holidays are seen by Primary Care Physicians first before coming to the ED. Hot water immersion is a simple and effective way of treating a patient with stone fish envenomation. This technique should be tried early, on-site as a first aid measure before even bringing the patient into the nearest ED.
2. This simple knowledge could be used by doctors to ensure that the patient is comfortable and without pain as soon as possible. Although highly potent pain medication was used in this case, we found that sometimes the simplest method such as hot water immersion is most effective.
3. The review of literature would be an interesting read for most primary care physicians to support their management of similar cases.

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