Localised tissue necrosis from marine puncture injury: first aid, definitive management and review of the literature

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Abstract

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We discuss a case of tropical marine envenomation from an unidentified marine creature via a penetrating injury to the left ring finger resulting in localised tissue necrosis. We present an evidence-based review of marine puncture wounds including first aid, hot water immersion therapy, antibiotic selection and definitive management.

Introduction

Infections arising from soft tissue puncture wounds in marine environments can be difficult to manage and may result in substantial tissue injury, particularly where the injury involves cytotoxic envenomation from a marine creature. We report a case of a puncture wound suspected to arise from a marine creature interaction with probable cytotoxic venom introduction and discuss some of the important clinical principles it illustrates.

Case report

The patient gave written consent for reporting of their case and images.

A 56-year-old female diver was undertaking an underwater photography dive at Ambon Harbour, Indonesia. At a depth of 10 metres sea water, when reaching backwards with her left hand to assist with stability, she experienced immediate and intense pain in her left ring finger following the delivery of a presumed cytotoxic venom into the pulp space and volar aspect of the distal phalanx of her left ring finger. She was unable to identify the source of injury.

Within 10 minutes, and back on the boat, the finger was immersed into fresh hot water, as hot as could be tolerated in the absence of a thermometer, while the boat returned to land. Hot water was regularly added throughout the 30-minute boat trip to maintain heat. Upon land, the injury was re-immersed into hot water, again maintained by regular input of hot water for a further 60 minutes. To manage pain, the diver was given panadeine/codeine and the finger was cleaned and irrigated with fresh water before being coated in Kenacomb ointment and dressed with a bandage. Figure 1 demonstrates the injury at day one.

Cephalexin 500 mg was administered every 12 hours for five days and the patient was monitored for systemic symptoms. Within 36 hours, the pain had subsided, and the diver chose to remain on site and continue with the underwater photography expedition. The left hand was kept protected by a surgical glove and the injury remained localised to the pulp space and volar aspect of the distal and middle phalanges of the left ring finger.

At day five, the diver flew home where she consulted with a general practitioner and was referred on to a surgeon. An area of necrosis was observed within the pulp space on day eight and by day nine the necrosis had spread into the volar aspect of the middle phalanx of the affected finger. Figure 2 demonstrates the progression of tissue necrosis from day eight to day nine.

A surgical debridement was performed by the surgeon on day nine. A detailed description of the surgery and the amount of necrotic tissue is not available. The finger was allowed to heal for four months without further surgical intervention. Figure 3 shows the injury site shortly after surgical debridement. By day 112 the finger had fully healed with full functionality restored, however minor scarring and mild loss of sensation over the volar aspect of the distal

Figure 1
Image taken on Day one of the patient's left ring finger following the delivery of cytotoxic venom from an unidentified marine creature into the pulp space and volar aspect of the distal phalanx

Figure 2
Image taken on Day eight (left) and image taken on Day nine (right) to demonstrate the spread of tissue necrosis over a 24 hour period

Figure 3
Image taken on Day 13 showing the injury site shortly after surgical debridement

Figure 4
Image taken on Day 112 after the injury was allowed to heal without further intervention; full functionality was restored, however minor scarring and mild loss of sensation over the volar aspect of the distal phalanx was reported

phalanx was reported. Figure 4 shows the affected finger at day 112 after the wound was allowed to heal without further intervention.

Discussion

Many marine creatures, particularly in tropical waters, can cause human envenomation.[1] It is reasonable to expect the prevalence of marine envenomation may increase with the possible rising sea temperatures due to climate change, and the growing popularity of marine recreational activities.[2] It is therefore important that clear advice about risk-mitigation strategies and appropriate first aid techniques are documented.

RELEVANT MARINE CREATURES IN INDONESIA

Indonesia's rich marine biodiversity includes numerous species capable of causing puncture envenomation to humans, posing significant medical concerns for coastal communities and divers. Notably, venomous fish such as stonefish (*Synanceia spp.*) and lionfish (*Pterois spp.*) possess dorsal spines that can deliver potent neurotoxins, resulting in intense pain, swelling, and in severe cases, systemic effects. Scorpionfish (Scorpaenidae) and rabbitfish (Siganidae) are similarly hazardous, with venomous spines capable of inflicting deep puncture wounds. Additionally, stingrays common in Indonesian waters have barbed tails containing venom glands, which can cause lacerating injuries complicated by toxin-induced tissue necrosis and secondary infections. Other marine creatures of concern include sea urchins, whose sharp spines may break off in the skin, introducing venom and foreign material, and certain species of catfish, which have venomous fin spines. Together, these marine hazards underscore the need for local awareness, prompt wound management, and appropriate medical treatment to mitigate the risk of severe envenomation in Indonesia's tropical marine environments.

FIRST AID STRATEGIES

When possible, positive identification of the marine organism can assist downstream medical care considering the risk of systemic reactions. Hot water immersion (HWI) is widely recommended as first aid for puncture envenomations from marine creatures such as stonefish, stingrays, and catfish; however, its efficacy and exact mechanism of action remain subjects of ongoing debate.[4,5] The prevailing theory suggests that the application of hot (but non-scalding) water, typically at temperatures between 40°C and 45°C, leads to thermal denaturation of heat-labile venom proteins, thereby reducing their toxic effects. Nonetheless, emerging evidence indicates that the primary benefit may instead stem from heat-induced modulation of nociceptors and pain pathways in the peripheral and central nervous systems, resulting in transient analgesia rather than direct venom inactivation.[4] Clinical reports and small studies support the analgesic effect of HWI, yet robust randomised trials remain limited, and optimal treatment parameters, including the ideal temperature and duration, are not clearly standardised.[1,4,5] Generally, immersion for 30 to 90 minutes or until significant pain relief is achieved is advised, but risks such as thermal burns must be carefully managed.[6,7] Consequently, while HWI remains a practical and low-cost intervention for marine stings, further research is needed to clarify its true mechanism, refine protocols, and confirm its effectiveness across different venomous species. The importance of clear advice for patients who might continue HWI therapy unsupervised at home has been stressed.[6] To mitigate the risk of iatrogenic thermal injury water temperatures should be limited to 40–45°C, or as hot as the patient can stand with a non-injured limb, and exposure time should preferentially be limited to 30-minute intervals with 30 minutes deferrals, or otherwise no more than 90 minutes of continuous immersion.[6]

Following HWI therapy for pain relief and toxin denaturation, the injury should be thoroughly irrigated with fresh water and inspected for foreign particles under sterile conditions by a medical practitioner. The patient should be monitored for systemic symptoms that may require cardio-respiratory support.[8] It is important to inform the patient about the possible symptoms caused by a retained foreign body that may require urgent medical attention such as surgical removal and targeted antibiotics.[9] These include:

- Persistent localised pain: ongoing or worsening pain at the wound site that does not resolve with expected healing time;
- Chronic swelling: localised edema that persists or worsens despite initial wound management;
- Palpable lump or mass: a firm nodule or foreign body that can sometimes be felt under the skin;
- Sinus tract formation: development of a draining sinus or non-healing wound with intermittent discharge;
- Non-healing ulcer: delayed or failed wound closure, often with granulation tissue that fails to epithelialise;
- Recurrent or persistent infection: recurrent cellulitis or abscess formation at the site, despite adequate antibiotic therapy;
- Chronic inflammation or granuloma: foreign body reaction leading to a localised inflammatory mass or granulomatous tissue;
- Restricted movement: if near a joint or tendon, the retained fragment may cause pain with movement or reduced range of motion; and
- Neuropathic symptoms: paraesthesia or localised numbness if the retained object impinges on a nerve.

The requirement of sutures for open wounds should be determined by the attending physician's risk assessment.[10]

The use of prophylactic antibiotics for marine sting envenomation remains a debated aspect of management, as not all puncture wounds require antimicrobial therapy. Current evidence suggests that prophylactic antibiotics may be indicated for high-risk wounds, including deep punctures (e.g., from stingrays or stonefish spines), wounds with retained foreign bodies or devitalised tissue, injuries in immunocompromised hosts, and wounds in anatomically high-risk sites such as the hands or feet. Prophylactic regimens should provide broad coverage for common marine pathogens, including *Staphylococcus aureus*, *Streptococcus* spp. and Gram-negative organisms such as *Vibrio* spp.[10,11] Single-agent options include doxycycline (effective against *Vibrio* spp. and some MRSA strains), or fluoroquinolones such as ciprofloxacin or levofloxacin.[10,11] Alternatively, combination therapy may be warranted for broader coverage: for example, doxycycline plus a third-generation cephalosporin (e.g., ceftazidime) or doxycycline plus trimethoprim-sulfamethoxazole for MRSA plus *Vibrio* risk.[10] Once signs of established infection are present, such as worsening pain, cellulitis, purulent discharge, or systemic signs, empiric therapy should cover the same spectrum. Oral options for mild infections include doxycycline, trimethoprim-sulfamethoxazole plus a beta-lactam (e.g., amoxicillin-clavulanate), or fluoroquinolones. For severe or rapidly progressive infections, especially in suspected *Vibrio vulnificus* cases, intravenous agents such as doxycycline plus ceftazidime, or a carbapenem, may be required. Tetanus prophylaxis should also be ensured, and surgical consultation considered for retained spines or necrotic tissue.[8] Ultimately, antibiotic choice should be guided by local resistance patterns and individual patient factors, with early microbiological cultures recommended when possible. Sterile wound care and regular inspection should be maintained until reasonable healing is confirmed, since tissue necrosis is a possible complication as seen in our case report. In this case prompt surgical debridement was effective in the healing process of the affected appendage and only mild scarring and loss of sensation resulted.

In remote settings where definitive medical care is limited, timely evacuation must be considered for marine envenomation injuries that present with clinical features indicating significant local or systemic complications. Stonefish stings, for example, are notorious for excruciating pain and the potential for progressive tissue necrosis, secondary bacterial infection, or cardiovascular compromise due to venom effects; evacuation is warranted if pain is unrelieved by first aid measures such as hot water immersion, or if antivenom administration is indicated but unavailable. Rapidly progressing cellulitis, myositis, or necrotic changes around the puncture wound, particularly when associated with highly virulent marine pathogens such as *Vibrio vulnificus* also demand urgent transfer to a facility capable of providing intravenous antibiotics, surgical debridement, and advanced wound care. Systemic signs and symptoms of sepsis, including fever, hypotension, tachycardia, or altered mental status, should prompt immediate evacuation due to the risk of septic shock and multi-organ failure. Additionally, the development of compartment syndrome, severe uncontrollable pain, neurovascular compromise, or signs of deep-space hand infections such as tenosynovitis or septic arthritis require surgical intervention not feasible in austere environments. In all cases, early recognition and prompt evacuation can be lifesaving, highlighting the importance of risk assessment and structured evacuation protocols for divers, fishermen, and coastal communities operating far from advanced medical services.

Surgical consultation should be promptly sought in cases of marine sting envenomation when there is clinical suspicion of retained foreign material, progressive soft tissue infection, or complications requiring operative management. Injuries from creatures such as stingrays, stonefish, and sea urchins often involve barbed spines or spicules that can fragment and remain embedded in the wound, serving as a nidus for persistent inflammation, granuloma formation, or secondary infection. If retained spines are suspected, evidenced by persistent pain, a palpable foreign body, or failure of the wound to heal, imaging (such as plain radiographs or ultrasound) is indicated, and surgical exploration may be necessary to remove the foreign material. Surgical debridement is also indicated when there is rapidly spreading cellulitis unresponsive to initial antibiotic therapy, deep space infections such as tenosynovitis or septic arthritis, abscess formation, or signs of necrotising soft tissue infection, particularly when marine pathogens such as *Vibrio vulnificus* are involved. Additionally, signs of compartment syndrome, including severe pain out of proportion to examination, tense swelling, or neurovascular compromise, necessitate urgent fasciotomy. Early surgical input can reduce the risk of chronic complications, such as functional impairment, and improve outcomes by ensuring adequate wound care, debridement of necrotic tissue, and appropriate drainage of purulent collections when indicated.

PREVENTION AND RISK MITIGATION

Protective swimwear that covers all or most of the skin, including gloves, maintaining buoyancy, avoiding contact with the seabed and marine life wherever possible, and staying vigilant about your surroundings are recommended strategies to avoid marine envenomation.[3] Restrictive bands such as rings on fingers should also be removed before entering the sea as they will pose a further risk in the event of marine envenomation and resultant swelling of fingers.

Conclusions

Divers should take the necessary precautions before entering the ocean and remain vigilant whilst in the water. In the event of marine envenomation, appropriate application of hot water immersion therapy to the affected area is recommended to improve clinical outcomes. Medical attention should be sought as soon as practical to allow the injury to be cleaned and inspected, and the patient may be prescribed prophylactic antibiotics particularly targeting gram-negative bacterial species. The patient should be monitored for systemic symptoms, and the affected area should be cleaned and inspected regularly until satisfactory healing can be confirmed and the possibility of tissue necrosis can be ruled out or managed. Surgical debridement of necrotic tissue should be performed when indicated.

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