

Causes and Treatments for Marine Wounds

Fenner PJ.
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SUMMARY

Wounds may be caused by a variety of marine organisms. These include the stings from jellyfish, penetrating wounds and lacerations. Each may behave differently to wounds from land-based animals. The causes and effects of marine envenomation, together with treatment of the acute wound and its possible long-term complications are discussed.

INTRODUCTION

Marine envenomation worldwide is extremely common. Deaths occur, but morbidity is the most common event needing first aid or medical treatment. Marine wounds bring their own complications and treatment is sufficiently different to discuss as a separate entity.¹

Marine wounds can be divided into 3 main types: -

- Jellyfish stings
- Penetrating wounds
- Lacerations

Jellyfish stings

Jellyfish have millions of tiny stinging cells (nematocysts) present on their tentacles, or less commonly on the actual jellyfish bell. These nematocysts contain a coiled tube, which can be everted rapidly, thus firing into the integument of its prey. The tube is sufficiently long to be able to reach the dermis, where venom is deposited.

Jellyfish venoms so far studied consist of mixtures of toxic and/or antigenic polypeptides and enzymes pathogenic to humans.² As they are antigenically active they initiate a specific immunological humoral and cellular response in human victims that can be used for immunodiagnosis.³

The reactions of these peptides and enzymes causes the characteristic jellyfish sting effect, which can be divided into 3 main levels of effect: -

Mild stings

Mild stings can be described as the nuisance jellyfish stings that occur worldwide when the only symptom is skin pain. Although this may be distressing for the victim particularly if a child, no lasting skin damage occurs, and no other signs or symptoms occur.

Skin blanching may occur at the original area of envenomation by a jellyfish. This is rapidly followed by a red erythematous mark corresponding with the tentacles of the jellyfish, which may develop into a raised red or white wheal. A surrounding erythematous "flare" is often present.

Each year between 10-2000 stings are treated by surf lifesavers alone, on the East Coast of Australia. The majority of these stings are from the common “Bluebottle”, *Physalia utriculus*.⁴ However, there are many species of jellyfish that cause similar stings, each of which may have a characteristic sting pattern. Fortunately it is unnecessary to actually identify the causative species before commencing treatment! It has been shown that the application of cold – using ice or cold packs (see below) - will alleviate almost 90% of skin pain from a jellyfish sting after a single application of between 5-15 minutes. A further application will reduce or stop some 96% of skin pain from jellyfish stings.⁵

Cold treatment for jellyfish envenomation

If fresh, adherent tentacles are present on the skin, they should be flushed off with seawater to prevent further stinging. If this is unavailable, tentacles can be picked off the skin with the fingers (only a harmless pricking of the fingers will be felt). Ice in a polythene bag, wrapped in a cloth or cold packs are applied to the stung area and left in place for 5 – 15 minutes. This will relieve most skin pain and reduce the inflammatory response. The ice or cold packs can be re-applied if the skin pain is unrelieved, or returns.

Moderate stings

Moderate stings can be regarded as those that not only cause skin pain, but also produce moderate skin damage such as blistering, or even frank necrosis of the skin, or which may produce mild to moderate systemic symptoms. Depending on the type of jellyfish and the severity and extent of the sting, these may include low back pain, painful muscles, painful breathing, nausea, vomiting and headaches.¹

Moderate stings causing blistering of the skin occur all round Australia (and the World) and may be caused by a variety of jellyfish species. In some instances necrosis of the skin in the sting area may occur.

First aiders should treat the skin pain with cold packs, but other symptoms requiring treatment will be treated empirically by medical personnel. When in doubt, treat as a skin burn.

Severe stings

Some jellyfish species, notably the cubozoan, or “box jellyfish”, can cause severe skin damage and even life-threatening systemic symptoms. These occur in tropical waters worldwide, usually in the summer months.⁶ The closer to the equator, the longer may be the season. The common Australian cubozoan jellyfish is *Chironex fleckeri*, commonly known as the Chironex box jellyfish, or North Australian Box-jellyfish. These are found in waters north of Agnes Water in Queensland, across the Northern Territory and south to Exmouth in Western Australia in the summer months. In the southern areas specimens may only be present in December and January, however the season extends closer to the Equator, and in the Northern Territory stings have occasionally been recorded in every month, with deaths from chirodropid stings occurring in all months except July. Sixty-six deaths have now occurred in tropical Australian waters from Chironex box jellyfish.¹

Victims feel as if they have been branded with red-hot irons, and may frequently scream with pain. Children tend to remain in the water, pulling at the tentacles with their fingers, thus increasing the envenomation: adults usually run quickly from the water. Tentacles usually remain stuck to the skin, a characteristic event with box jellyfish envenomation. However, the longer the tentacles are in contact with the skin, the greater the envenomation will become, making an initial small envenomation into a life-threatening one.

The initial sting is a vivid linear erythematous flare with a white ischaemic centre wherever tentacle contact has occurred. Often a fresh sting will have the appearance of a “frosted ladder” with remaining nematocysts causing a glistening pattern of multiple cross hatching, which corresponds to the batteries of nematocysts on the actual jellyfish tentacle. Surrounding oedema rapidly develops and the most seriously envenomated skin areas become dark. Vesiculation may occur, with partial or full thickness skin death. Scarring usually develops and is much more likely to result if secondary infection supervenes.

The treatment of box-jellyfish is covered below. However, it must be stressed that vinegar, when poured for a minimum of 30 seconds over tentacles that remain on the skin, will totally de-activate any remaining nematocysts (stinging cells). It does NOT ease pain, nor does it reverse the effects of venom already injected. Vinegar use is greatly misunderstood by the general public who regard it as a panacea for all box jellyfish sting effects.

First aid treatment of box jellyfish envenomation¹

Whilst others are sent for ambulance / medical help, assess the victims airway, breathing and circulation. If necessary, treat with mouth-to-mouth resuscitation (EAR), or cardio-pulmonary resuscitation (CPR). As soon as possible, pour vinegar over the stung area for a minimum of 30 seconds to inactivate remaining stinging cells on any adherent tentacles left on the skin. AFTER vinegar application, compression bandages should be applied directly over the stung area for major stings, i.e. those covering an area more than half of one limb, or causing impairment of consciousness, breathing or circulation. If vinegar is unavailable, the rescuer should pull tentacles off using their fingers (only a faint, harmless prickling will be felt) - before applying the compression bandages

If available, use CSL *Chironex* antivenom for all major cases (see above). Three ampoules each containing 20, 000 units may be given intramuscularly, above the bandages, by a trained health professional on the beach. Further ampoules may be given intravenously by medical personnel. There is circumstantial evidence that the use of antivenom greatly reduces the local inflammatory response and almost immediately relieves pain.⁷ It has also been suggested that antivenom reduces scarring.⁸

Cold packs may be used (for 15 minutes and repeated when necessary) to help ease the skin pain in conscious victims.

Delayed allergic reaction to jellyfish stings

Because they are polypeptide proteins all jellyfish venoms possess the ability to cause delayed allergic reactions. In practice, however, it is usually the cubozoan jellyfish that produce delayed allergic reactions.¹

Characteristically, the initial skin marks of the jellyfish envenomation clear, then suddenly recur in exactly the same stung areas as the original sting.

No life-threatening allergic reactions to a chirodroid sting have yet appeared in the literature. However, delayed local reactions to *Chironex fleckeri* stings are well documented.¹
⁹ The reappearance of these lesions at the original site may appear as a mild 'papular urticaria' or a red, itchy and weeping vesicular eruption, often with some local oedema, some 10-16 days after the initial sting without further contact with the venom. This event appears to be more commonly associated with patients who have a history of some immunologically-based abnormal condition, such as atopic or asthmatic individuals.¹

Treatment of delayed allergic reactions

Although soothing creams and cortisone-based creams are often used, the most effective treatment is oral steroids in a dose of 25-50mg daily, depending on the age and size of the victim. This is used for about 3 days and then may be withdrawn abruptly. High-potency cortisone-based creams can then be continued, if necessary.¹

“Other” dermatological lesions from jellyfish

Pelagia noctiluca (“little mauve jellyfish”), which occasionally occurs in Australian waters, has a venom, which has been shown to have significant antigenic properties.^{10 11} Recurrent lesions at the same site following single envenomations have been reported with *Pelagia*, *Physalia*¹² and *Chironex*.¹ Granuloma annulare after a *Physalia* sp. sting has also been reported on one occasion¹³ and reactivating local herpes simplex has been seen at the site at least twice.¹ Local neuropathy at the site will resolve within six months.¹

Lesions from *Pelagia* have also produced both hypo- and hyper-pigmentation and keloid formation have also occurred although scarring is rare.¹⁴ These may present cosmetic problems, particularly in young and/or female patients. Cryosurgery with liquid nitrogen and/or local steroid infiltration has been shown to be useful for keloids.¹¹ Topical hydroquinone bleaches diminished the intensity of pigmented scars from jellyfish stings.¹⁵ If in doubt, treat the wound as a burn.

Penetrating marine wounds and envenomations

Marine animals with spines or barbs may cause penetrating injuries.

Barbs

Stingrays often burrow under the sand in shallow water. The usual method of injury is a reflex forward whip of the tail when the ‘wings’ are trodden on (often by an unsuspecting fisherman wading through the shallows). The tail contains one or more sharp barbs, which usually embed in the skin of the victim and break off. Occasionally they may glance across the skin causing a laceration, which may be quite deep and extensive.

The wound is usually (though not always) acutely painful. The barb sheath ruptures on penetration of the affected area, leaving tissue and venom, which will cause immediate pain, and later, infection and possible local necrosis. Most occur on the lower limbs but there have now been two deaths in Australia after the barb penetrated the heart.^{16 17} Other serious injuries have also occurred after the barb penetrated the chest or abdomen.¹

Spines

The most notorious marine animal with spines must be the stonefish, which is present in the Indian and Pacific Oceans north to China, east to Hawaii and south to Australia. No deaths have occurred in Australia, and evidence for world deaths remains flimsy.¹ The master of camouflage, it is a true fish 20-30 cms long with tough, warty skin, which may be covered with slime. It is usually the colour of its surrounds (frequently dark brown) and difficult to see. Along the back of the fish are 13 spines, which when stepped on, penetrate the skin of the victim injecting venom causing immediate, severe pain which may cause the patient to become frantic, or delirious. Often bluish discolouration is present around the puncture site. The area surrounding is usually oedematous. Local limb paralysis, nausea, vomiting, and faintness may occur.¹

Many marine animals have spines for defense. These include many fish, sea urchins and the Crown of Thorns seastar. They all may leave retained foreign bodies, including tissue and broken-off barbs and spines, which may cause local damage, bruising, bleeding or pain. If venom is present and deposited during envenomation, severe local pain may occur, as with the stonefish.¹

First aid

Characteristically penetrating marine injuries, unlike jellyfish stings, are greatly relieved by the application of heat. Although the venoms are heat-labile, it is usually at a temperature higher than that required to stop the pain - and fortunately below that causing skin damage! It cannot be currently proven how heat application gives pain relief in penetrating marine wounds, but such relief is usually dramatic.¹

Immerse the wounded area in hot water up to 41-43° Celsius. As the person may be in excruciating pain they are usually unaware of the temperature of the water and may suffer burns if the water is too hot. The rescuer should first test the water! In the author's experience it may be necessary at times, if medical aid is not available, to treat the pain of these penetrating marine injuries for up to 8 hours.

Medical treatment

Previously-suggested treatments for stingray envenomation were flushing the wound with saline or antiseptics (such as betadine),¹¹ excision if necessary, leaving the wound open to heal by primary intention, helping prevent commonly-associated infection.

The author now excises the wounded area, if possible, and packs the crater with an alginate-based wick to allow healing by secondary intention. These dressings are useful in toxin absorption and are left in place for as long as possible. They frequently fall out at about 8-10 days, or are then easily removed without pain or damage to the healing wound.¹⁸ Tetanus immunisation is advised. Follow-up to exclude secondary infection may be necessary. However, a skilled medical team with advanced imaging MUST carefully evaluate wounds to the chest or abdomen without delay, as remaining venom within the stingray barb tract may cause muscle necrosis, which has previously caused death from cardiac tamponade,¹⁷ or severe life-threatening pleural and chest infections.¹⁹ Surgical debridement of this tract and thorough cleansing is essential to prevent such complications.

Stonefish envenomation is acutely painful and local anaesthetic, preferably by local nerve block may be needed, together parenteral opioids, if necessary. Antivenom is available for intractable pain, or systemic symptoms.

Tetanus immunisation is advised. Follow-up to exclude secondary infection may be necessary.

Lacerations

The barbs of marine animals, such as the stingray may cause deep lacerations and even death, or the hard, chitinous outer coverings of coral reefs or shellfish may damage a victim's skin accidentally. Coral is a living substance with the soft outer corals containing the same type of nematocysts (stinging cells) as jellyfish. However, the venom is rarely painful, but retained material including the nematocysts or other foreign materials present on the coral may become embedded in the wound. This often causes a quite intense chemical reaction within the wound and they very often become infected.¹ Effective first aid treatment is essential.

After applying the normal principles of stopping bleeding that may be present, it is important to thoroughly cleanse the wound to remove retained foreign matter. This may require local anaesthetic nerve block, or even general anaesthetic in the case of large abrasion, especially in children.

Sterile dressings should be applied and the wound checked regularly every few days to observe for signs of developing infection. Again, the author finds that alginate-based dressing seem to reduce infection, possibly by absorbing toxins.

Tetanus immunisation is essential.

Marine wound infections

Marine wounds are often contaminated by different organisms to those found in normal wound infections.^{1 20} These include *Vibrios*, *Altermonas*, *Erysipelothrix*, *Mycobacteria marinorum* and marine varieties of *Pseudomonas* (*P. marina*), which do not respond to antibiotics normally used in wounds. The antibiotics of choice if culture and sensitivity are not immediately available are doxycycline or minomycin (100mg daily) or 3rd generation cephalosporins.¹

It is essential that when wound cultures from marine wounds are sent for microbiology, that the request form states that it is a marine wound. The laboratory will then ensure that the culture medium has a saline base, as normal growth media would inhibit salt-loving bacteria, and wound infection may be missed.

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