Case Series

Stonefish Envenomations of the Hand – A Local Marine Hazard: A Series of 8 Cases and Review of the Literature

JYL Lee,[1]*MBBch, M Med (Surg), MRCS (Edin)*, LC Teoh,[1]*M Med (Surg), FRCS (Glas), FAMS*, SPM Leo,[1]*MBBS*

Abstract

Introduction: The Singapore shoreline has changed significantly in recent years, but the stonefish (*Synanceia sp.*) continues to inhabit our native waters and human envenomation still occurs regularly. In this paper, we document their clinical course, review our management experience and propose a treatment algorithm. Clinical Picture: Envenomation is associated with appreciable local morbidity, excruciating pain and gross oedema of the affected limb. Severe systemic morbidity and deaths have been reported in the literature but are very rare. Treatment: Prompt first aid with immersion in hot water (45°C) inactivates the venom. Supplementary analgesia, tetanus prophylaxis and broad-spectrum antibiotics are recommended. Specific anti-venom is available and indicated for severe envenomations with systemic symptoms. Complicated puncture wounds and retained spines require surgical debridement. Outcome: Eight cases of stonefish envenomations to the hand were treated over the last 1.25 years (October 2001 to January 2003). Length of hospital stay averaged 3.9 days. There were no deaths or significant systemic morbidity, but 1 case required surgical debridement for local necrosis. Complete resolution of swelling, with return to full function, occurred on average by 8.2 days. Conclusions: Prompt recognition of envenomation, early first aid and hot water soaks result in rapid relief of pain and symptoms. Our local experience suggests that the majority of stonefish envenomations do not result in significant or protracted morbidity and require only supportive management. Systemic morbidity and mortalities are rare.

Ann Acad Med Singapore 2004;33:515-20

Key words: Bites and stings, Fish venoms, Hand injuries, Marine toxins, Poisonous, Stonustoxin, Synanceja,

Introduction

The Singapore shoreline has changed significantly over the last 30 years, but the stonefish (*Synanceia sp.*) continues to inhabit our native waters and human envenomation still occurs with relative frequency. In this paper, we document the clinical course, review our management experience and propose a treatment algorithm.

Stonefish are a common environmental hazard in the indo-pacific region and inflict injury by penetrating the skin with venom-coated spines, causing excruciating pain and gross oedema involving the entire extremity. Their appearance and habits make them difficult to detect and avoid.

Stonefish envenomations are less common in Singapore now due to changes in our coastal demographic and landscape. However, when they do occur, they are attended by appreciable local morbidity. Severe systemic morbidity and deaths have been reported in the literature, but are rare.

We report our recent experience of 8 cases of stonefish envenomation, documenting their presenting features and clinical course. Management is simple and supportive in the majority of cases.

Materials and Methods

Over the past 1.25 years (October 2001 to January 2003), 8 cases of stonefish envenomations to the hand were treated at the Department of Hand Surgery, Singapore General Hospital. Identification of the offending fish was made by direct visualisation in 50% of cases (i.e., the fish was brought in to the Accident & Emergency Department) (Table 1 and Fig. 1). In the other half, identification was either from a picture chart or strong oral history.

[1] Department of Hand Surgery
Singapore General Hospital, Singapore
Address for Reprints: Dr JYL Lee, Department of Hand Surgery, Singapore General Hospital, Outram Road, Singapore 169608.

Table 1. Eight cases of Stonefish Envenomation Treated at the Department of Hand Surgery, Singapore General Hospital

No.	Age (y)/Sex/ Nationality	Stonefish identification	Site of injury	Contact	Length of hospital stay	Hot water soaks used?	Antibiotics	Complications	Outcome
1	38/M/ Singapore	Strong history	Right ring finger Swollen to forearm	Swimming Sentosa	9 days	No	IV Augm, Clinda 8 days PO Augm, doxy, cipro 1 week	Debridement done. Slight loss of fingertip sensation.	Superficial fingertip necrosis
2	32/M/ Myanmar	Direct ID	Right palm Swollen to elbow	Fishing Changi Point	5 days	Yes	IV Ceftaz, clinda 5 days PO Augm, doxy 1 week		Resolution 7 days
3	24/M/ Myanmar	Direct ID	Left palm Swollen to arm, axilla	Fishing Changi Point	6 days	Yes	IV Ceftaz, clinda 5 days PO Augm, doxy 1 week		Resolution 8 days
4	33/M/ China	Direct ID	Right middle finger	Beach-combing St Johns' Island	3 days	Yes	PO Cephalexin, doxy 1 week		Defaulted follow-up
5	35/M/ China	Picture ID	Right index finger Swollen to mid forearm	Beach-combing	4 days	Yes	IV CP, clox, genta 4 days PO Pen, clox, bactrim, doxy 1 week		Resolution 6 days
6	13/M/ Singapore	Picture ID	Right ring finger Swollen to wrist	Swimming	2 days	Yes	IV CP, clox, genta 2 days PO Pen, clox, doxy 1 week		Resolution 14 days
7	30/M/ China	Picture ID	Left palm Swollen to wrist	Swimming	0.5 days	Yes	PO Pen, clox and bactrim 1 week		Defaulted follow-up
8	30/M/ China	Direct ID	Right index finger Swelling to wrist	Swimming Sentosa	2 days	Yes	PO Pen, clox, doxy 1 week		Resolution 6 days

Augm: amoxicillin/clavulanate (Augmentin); Ceftaz: ceftazidime (Fortum); Cipro: ciprofloxacin; Clinda: clindamycin; Clox: cloxacillin; CP: crystalline penicillin; Genta: gentamicin; Doxy: doxycycline; Pen: penicillin

All 8 cases presented to the Accident and Emergency Department within hours of envenomation, complaining of an excruciating pain at the site of puncture that radiated up the arm. One patient (Case 3) reported pain extending as far as the ipsilateral axilla. This was associated with the rapid onset of gross oedema in the affected hand and upper extremity, usually as far as the elbow. A mild erythema was also present. All our patients had stable cardiovascular parameters and none of them reported systemic symptoms.

Six of the 8 cases (75%) were foreign nationals and all cases had sustained their injuries while swimming, fishing or beach-combing on our local beaches. Three cases were punctured in the palm, while the majority (5/8) sustained stings to the fingers. With the exception of case 1 (our first case), the other 7 cases were subjected to the treatment algorithm outlined in Figure 2. Plain radiographs in 2 views were performed in all cases to exclude retained spines or integument.

Results

Patients were admitted for monitoring. Regular hot water soaks (45°C) were administered until the pain resolved. Most cases were given prophylactic intravenous antibiotics for the first 2 to 5 days, before conversion to oral therapy. Patients were nursed with the limb elevated in a brooke sling and mobilisation therapy was encouraged to prevent joint stiffness. They were discharged when the swelling and erythema had begun to subside and were pain free. One week of oral antibiotics were continued at discharge. The antibiotic regimen had initially varied according to surgeon preference but was later standardised.

Admission times averaged 3.9 days. One patient (Table 1, Case 7) had prompt resolution of pain and swelling after first aid measures and hot water soaks, and only required a few hours of observation in the accident and emergency department. The longest admission of 9 days was due to the complication of local skin necrosis at the puncture site requiring surgical debridement (Case 1). Surgery was only required in this 1 case (12.5%). Complete resolution of swelling with return to full function occurred on average by 8.2 days.

Discussion

The stonefish (*Genus Synanceia*) is considered to be the most dangerous venomous fish in the world and certainly the most venomous of the Scorpaenidae family, which are all characterised by their ability to envenomate using a variety of specialised spines.[1] Four species of stonefish have been described: *S. horrida, S. trachynis, S. verrucosa* and *S. erosa*.[2] *Synanceia horrida* is indigenous to the shallow waters of our indo-pacific region.

Stonefish resemble weed-covered stones. They may attain a length of 38 cm and a weight of 1.5 kg.[1] They have a mottled brown-green colour with bony eminences and deep hollows around the head, and wart-like bumps on their trunk (Fig. 3). They are often covered by a coat of slime to which algae and other organisms adhere. This excellent camouflage, and their habit of partially burying themselves in the sand, makes them difficult to detect and avoid.

Their venom apparatus consists of 13 dorsal spines, 3 anal spines and 2 pelvic spines. Venom is released from paired venom glands lying in 2 lateral grooves at the base of each spine when mechanical pressure is applied.[3] These venomous spines are not used for hunting and are a defensive mechanism only. Stonefish are generally no threat to humans unless accidentally stepped on or carelessly handled.

The venom likely consists of 4 biologically active factors: (1) hyaluronidase fraction, (2) capillary-permeability factor, (3) a toxic or lethal fraction[4] and (4) a pain producing factor.[5]

The capillary permeability factor contributes to extensive oedema after envenomation[6] (Fig. 3) and may also account for other systemic effects such as haemorrhagic pulmonary oedema. The lethal fraction (Stonustoxin SNTX, 148,000 mol.wt.)[6] is a potent hypotensive agent which has myotoxic[7] and neurotoxic[8] activity. Marked hypotension appears to be the primary cause of death in animals in vivo studies.[7]

The venom is an unstable protein, with a pH of 6.0 and a molecular weight of 150,000. In vitro, it may be denatured by heat (2 min at 50ºC), acid and alkalis (pH >9, pH <4), potassium permanganate and congo red.[9] Its heat labile nature is the basis for its treatment.

Injury and envenomation have been described in both the natural environment (e.g., divers, fishermen and waders) and in the domestic setting (aquarium handlers).[10] Envenomation results in excruciating localised pain and gross oedema, which may involve the entire extremity and regional lymph nodes, peaking around 60 to 90 minutes and lasting up to 12 hours if untreated.[11] The severity of pain may lead to unconsciousness and possible drowning. Systemic effects may include pallor, diaphoresis, nausea, muscle weakness, dyspnoea, headaches and delirium; convulsions, hypotension and postural syncope have been reported though we have not seen these in our series.

Local circulatory stasis results in a bluish cyanotic colour in the region of the puncture wound (Fig. 5). Vesicle formation is common in envenomation to the hands and may be followed by tissue sloughing, cellulitis and surrounding hyperaesthesia. Patel and Wells[12] describe 3 grades of tissue reaction in the hands after Lionfish (*Pterosis volitans*, Family *Scorpaenidae*) envenomation: 1) erythematous reaction, 2) blister formation and 3) dermal necrosis. They have recommended early blister excision to prevent

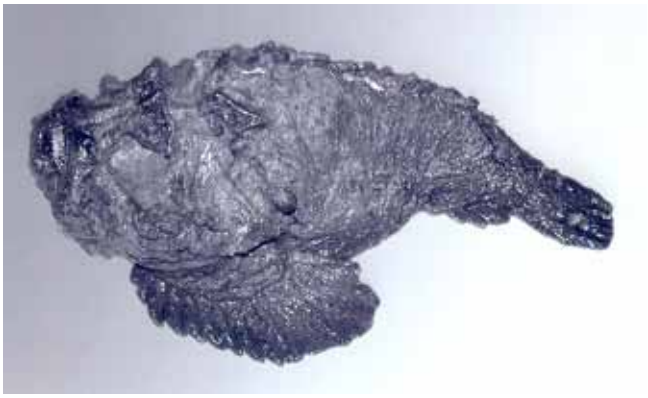

Fig. 1. A stonefish brought to the Accident and Emergency Department for identification. Its venom apparatus includes paired venom glands on each of its 13 dorsal spines.

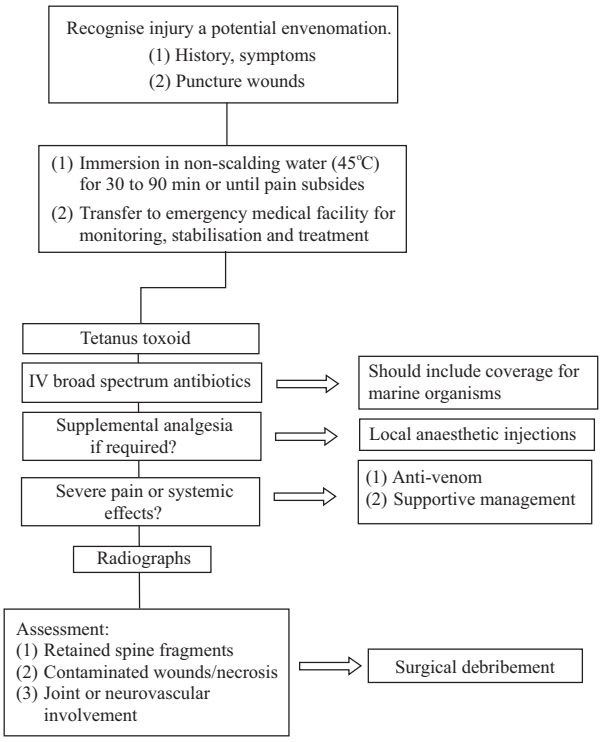

Fig. 2. A suggested management algorithm for the treatment of stonefish envenomations.

dermal necrosis, as the blister contains residual active venom. This was the case in one of our patients (Table 1, Case 1). It cannot be ascertained with absolute certainty why this first case developed local skin necrosis. However, it is suspected that because hot water soaks were not used in this case, local persistence of the active venom may have been responsible. The subsequent 7 cases were subjected to hot water soaks as part of the algorithm outlined in Figure 2 with rapid resolution of symptoms and no similar wound complications.

Fig. 3. The stonefish (*Synanceia horrida*) resembles weed-covered stones and is excellently camouflaged.

Fig. 4. Envenomation causes excruciating localised pain, with erythema and oedema that may involve the entire limb. Hot water soaks (45°C) provide rapid analgesia.

Fig. 5. Local blister formation may occur which may require excision to avoid dermal necrosis.

Respiratory failure[13] and haemorrhagic pulmonary oedema[14,15] have been reported. Deaths following envenomation have also been reported,[16-18] however, these are isolated case reports or small series, with information that is largely anecdotal. Such cases may have resulted from inadequate delivery of first aid, the inability to recognise systemic toxicity and institute appropriate supportive measures, or by inadequate debridement resulting in subsequent secondary wound infections, leading some authors[19] to believe that stonefish envenomation does not in fact cause serious toxicity if appropriately treated.

Phoon and Alfred[20] reported the largest series comprising 81 cases over a 4-year period in a single hospital (Pulau Bukom Hospital, Singapore). There were no deaths or severe morbidity in this series, and their cases involved mostly fishermen and other islanders. The incidence appears to have decreased sharply over the past 35 years, possibly due to the decrease in local fishing activity and changes in the coastal landscape.

Envenomation should be promptly recognised from the patient's history, symptoms and presence of puncture wounds, and treatment commenced. The patient should be laid supine; the affected limb elevated and washed with clean water. Any spines or integument should be gently removed and bleeding is controlled by direct pressure. Limb immersion in hot water (45ºC) for 30 minutes or until the pain subsides[11] inactivates the heat labile venom and effects rapid relief. Care should be taken to prevent scalding as the affected limb may experience some anaesthesia following envenomation. We find these hot water soaks to be the most beneficial treatment modality.

Adequate pain relief is a priority and supplemental analgesia with local anaesthetic injections of lignocaine (1% to 2% lignocaine without adrenaline) should be given if required. Local injections of hyoscine N-butylbromide and emetine hydrochloride have also been described to provide relief.[9] Tetanus prophylaxis is indicated in all marine animal injuries. Observational monitoring for at least 6 to 12 hours is advised. Plain radiography is required to exclude retained spines, aided further by ultrasonographic studies if necessary.

Stonefish antivenom is available from CSL Limited (formerly Commonwealth Serum Laboratories), Melbourne, Australia, and is indicated for severe pain, systemic symptoms, weakness, paralysis or an injection of large amounts of venom. It is administered as an IM injection in a dose of 1 ampoule (2000 U) for every 1 to 2 punctures to a maximum of 3 ampoules for more than 4 punctures.[21] Known severe sensitivity to horse serum is a contraindication to its use.

All marine injuries are at risk of secondary infection and antibiotics are recommended for all puncture wounds of the hand and foot because of the high incidence of ulceration, necrosis and secondary infection. Empirical broad-spectrum prophylactic antibiotics should cover vibrio and aeromonas infections as well as mycoplasma marinum and erysipelothrix rhusiopathiae infections. Our recommendations are:

1) Initial (first 48 hours):
   Doxycycline 100 mg BD orally, together with:
   a. IV crystalline penicillin/ cloxacillin/ ceftazidime (covers common organisms and *Vibrio sp*.) or
   b. IV ceftazidime (fortum) 2 g 8 h IV and clindamycin 600 mg 6h IV (Group A Strep cover) or
   c. IV ciprofloxacin/ crystalline penicillin/ cloxacillin (when *Aeromonas sp*. is suspected)

A vibrio-type necrotising infection should present itself within 48 h and therapy would then be directed towards this. On the other hand, if the swelling and erythema have begun to subside, patients are switched to broad-spectrum oral antibiotics.

2) Follow-up oral antibiotics (for an additional 5 to 7 days):
   a. Amoxicillin/ clavulanate (Augmentin) 625 mg BD and doxycycline 100 mg BD, or specific antibiotics if cultures are available.

Where there is overt infection, local swab or tissue cultures should be taken and the antibiotics adjusted according to antibiotic sensitivity results.

Wound Care and Surgical Debridement

Visible foreign material, integument or spines should be removed with a forceps. Retained spines continue to envenomate,[22] and, in the long term, may result in chronic inflammation, granulomata and secondary infection. Surgical consultation should be sought for all complicated puncture wounds, including retained fragments that cannot be removed manually or for wounds and fragments in close proximity to joints, nerves or vessels. Those involving weight-bearing surfaces may result in chronic pain. Extraction of spines may require the use of an operating microscope, fluoroscopic or ultrasound control.

Prevention may be the best approach. Waders and swimmers should avoid doing so in bare feet, especially at night and in poor visibility. A shuffling gait may minimise impalement. Marine life should not be handled unnecessarily and hidden crevasses should not be explored without gloves. It must be remembered that although shoes, diving booties and gloves do provide some measure of protection, the stout sharp spines of the stonefish are said to be able to penetrate the soles of a tennis shoe.[23]

Conclusion

The stonefish continues to be a local environmental

hazard to the unwary swimmer or angler. Their excellent camouflage makes them difficult to detect and avoid. Envenomation can lead to appreciable local morbidity, excruciating pain and gross oedema of the affected limb. It is our local experience that the majority of stonefish envenomations do not result in significant or protracted morbidity and require only supportive management. Severe systemic morbidities and mortalities have been reported but are very rare.

Pre-hospital care should address the prompt recognition of the injury as a potential envenomation, gentle removal of spines, direct pressure to control bleeding, early immersion in hot water (45ºC) to inactivate the venom and transport for definitive evaluation. Hospital management must address the venom exposure and accompanying inflicted trauma. Supplementary analgesia, tetanus prophylaxis and broad spectrum antibiotics directed at marine pathogens are recommended. Specific anti-venom is available and indicated for severe envenomations with systemic symptoms. Complicated puncture wounds and retained spines will require surgical consultation for debridement (Fig. 2).

REFERENCES

1. Halstead BW. Class osteichthyes: venomous scorpion fishes. In: Poisonous and Venomous Marine Animals of the World. 2nd ed. Princeton, New Jersey: Darwin Press, 1988:839.
2. Russell FE. Marine toxin and venomous and poisonous marine animals. Adv Marine Biol 1965;3:255-384.
3. Gopalakrishnakone P, Gwee MCE. The structure of the venom gland of the stonefish *Synanceja horrida*. Toxicon 1993;31:979-88.
4. Weiner S. Observations on the venom of the stonefish (*Synanceja trachynis*). Med J Aust 1959;1:620-7.
5. Austin L, Gills RG, Youatt G. Stonefish venom: some biochemical and chemical observations. Aust J Exp Biol Med Sci 1965;42:79-90.
6. Poh CH, Yuen R, Khoo HE, Chung M, Gwee M, Gopalakrishnakone P. Purification and partial characterization of stonustoxin (lethal factor) from *Synanceja horrida* venom. Comp Biochem Physiol 1991;99B: 793-8.
7. Low KSY, Gwee MCE, Yuen R, Gopalakrishnakone P, Khoo HE. Stonustoxin: effects on neuromuscular function in vitro and in vivo. Toxicon 1994;32:573-81.
8. Low KSY, Gwee MCE, Yuen R. Neuromuscular effects of the venom of the stonefish *Synanceja horrida.* Eur J Pharmacol 1990;183:574.
9. Edmonds C, Lowry C, Pennefather J. Dangerous marine creatures. Diving and Subaquatic Medicine. 3rd ed. Oxford, England, Boston: Butterworth-Heinemann, 1992:318-47.
10. Chan TY, Tam LS, Chan LY. Stonefish sting: an occupational hazard in Hong Kong. Ann Trop Med Parasitol 1996;90:675-6.
11. Auerbach PS. Marine envenomations. N Engl J Med 1991;325:486-93.
12. Patel MR, Wells S. Lionfish envenomation of the hand. J Hand Surg 1993;18A:523-5.
13. Lehmann DF, Hardy JC. Stonefish envenomation. N Engl J Med 1993;329:510-1.
14. Khoo HE, Yuen R, Poh CH, Tan CH. Biological activities of *Synanceja horrida* venom. Nat Toxins 1992;1:54-60.
15. Kreger A S. Detection of a cytolytic toxin in the venom of the stonefish (*Synanceia trachynis*). Toxicon 1991;29:733-43.
16. Cooper MNK. Historical vignette – the death of an Australian army doctor on Thursday Island in 1915 after envenomation by a stonefish. J R Army Med Corps 1991;137:104-5.
17. Smith JLB. Two rapid fatalities from stonefish stabs. Copeia 1957;3:249.
18. Bottard A. Les Poissons Venimeux. 1889 Paris: Octave Doin (quoted in reference 20 – Phoon WO and Alfred ER).
19. Flecker H. Injuries from stonefish. Med J Aust 1956;2:371-3.
20. Phoon WO, Alfred ER. A study of stonefish (*Synanceja*) stings in Singapore with a review of the venomous fishes of Malaysia. Singapore Med J 1965;6:158-63.
21. Stonefish antivenom information sheet. Australia, CSL Limited. Available at: http://www.csl.com.au. Accessed July 26, 2004.
22. Gallagher SA. Lionfish and stonefish. eMedicine J 2001;2:7.
23. Fenner P. Marine envenomations. Aust Fam Physician 1987;16:93-104.