Stone Fish and Stingrays – Some Notes on the Injuries That They Cause to Man

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SUMMARY: A review is presented of past and present records of injuries caused by these fish with particular reference to the occasional fatalities that have ensued.

The wide geographical range of species of both types indicate a variety of current Service postings where such injuries can be sustained.

The pharmacological actions of the venoms of both types are summarised as far as they are known.

Modern lines of management are described which stress the need for thorough debridement of these injuries.

Introduction

After preparing a historical vignette of the death during the First World War following envenomation by a stone fish, of an Australian Army Medical Corps officer on Thursday Island in the Torres Strait(1), it was suggested to this author that a review of the effects on man of stone fish and stingray injury would be of interest to readers of the Journal. A 17 month period spent as an intern and resident medical officer at Cairns Base Hospital, in far north Queensland, necessarily meant my undertaking the out-patient and sometimes the in-patient care of victims of these fish. The best description that I came across, whilst there of the effects of stone fish venom on man was in the pages of a paperback reprint of a minor Edwardian classic. It read as follows:

"Suppose that fella nail go along your foot, you sing out all a same bullocky all night. Leg belonga you swell up and jump about ? Bingie (belly) belonga you sore fella. Might you die."(2)

E J Banfield, an English journalist who sought relief from overwork in a hedonistic existence on one of the beaches of Dunk Island off the North Queensland coast of Australia, published the above verbatim description by a local Aboriginal of the effects of a stone fish sting in his *Confessions of a Beachcomber* in 1908. No casualty officer faced with a recently envenomated patient would find much in this description to argue with.

However all medical practitioners who manage cases of stone fish and stingray envenomations will sooner or later encounter the lurid folk image which these fish project in the minds of the public. All too often this image is at best inaccurate and at worst positively dangerous. That one's fellow practitioners can also share similar beliefs has been a surprisingly frequent as well as a disconcerting experience to the author.

This paper aims to dispel such misconceptions by presenting a review of past and current literature, with particular reference to generally accepted modes of treatment of the injuries which these fish can cause to man. As the geographical range of stingray and stone

fish species extends through the tropical Atlantic, Indian and Pacific Oceans, with specimens of both types being recorded from sites up to 15° of latitude north and south of the tropics(3), it may be seen that there are a wide variety of current Service postings where such injuries can present.

For the purposes of this review stone fish are defined as species of the *Synanceia* genus and stingrays as members of the *Rajiformes* order (skates and rays).

Stone Fish and Stingrays Contrasted

The Post-Graduate Bulletin of the Medical Committee of the University of Sydney for March 1963(4) describes the structure and function of the venom glands of the stone fish thus:-

"Along the back of the stone fish is a row of thirteen strong spines, hidden by puckered skin which also conceals the bags of poison, one on each side of each of these spines. Though the skin of the fish may be easily slipped back to leave the end of a dorsal spine protruding, the poison glands are more firmly secured, and their position is such that their venom is squeezed out by the slightest pressure. It is then forced along deep grooves which extend up each side of the spine to their tips, and is so conveyed into the depths of any wound they may inflict (Fig 1). The spines of a stone fish can penetrate a sandshoe to enter a wader's foot.

The poison is extremely virulent, the stone fish being the most venomous fish known, and immediately causes such fearful pain that a victim may become almost demented, and may fall in the water and risk drowning. His limbs may swell, and if he cannot obtain medical treatment, he may die."

The Post-Graduate Bulletin continues:-

"In the South Sea Islands the stonefish is called Nofu, No'u or Nohu (the "waiting one"), and is dreaded by the natives, who treat wounds from it by applying leaves to the unaffected parts!

The Australian Aborigines of the Cape Bedford district, Queensland, used to produce a beeswax model

of the "Dornon", as they called the stonefish, for part of their initiation ceremonies. The model was placed on the ground and the poisonous nature of the fish was explained to the youngsters by the elder men, who danced around and around and pretended to search for and spear it. Finally, one native trod on the sticks which served as spines on the model and, acting as if he was poisoned, uttered an unearthly yell and fell to the ground as if in agony. Notwithstanding such dramatic demonstrations, some of the keenest-eyed natives occasionally suffer through failing to recognize this hidden danger of the reefs.

The flesh is edible, indeed delicious, so natives are only too eager to turn the tables on the fish by spearing it before it can wound them."

By contrast, the same publication describes the stingray as a very flat shark type and continues:-

"If you can imagine that the shark's five gill slits have come to lie on the lower surface of the body instead of the sides of the head and body, and the whole thing has been squashed as though it had gone through a mangle, then you get the ray, which is dark on the top and light below. The dangerous kind that we have to look for is the stingray, in which there is a long barbed spike on the back. It has very fine venom glands and ducts."

Fig 1. Venom apparatus of a stone fish:

A. Dorsal spine viewed from behind, showing paired lateral venom glands (VG). Note tip of spine (S) and narrow venom ducts (VD), both passing through a narrow opening in the tough integumentary sheath (IS).

B. & C. A human has trodden upon the fish, the skin is pushed down the spine (large arrows) and the venom gland is compressed by the crumpled sheath. This pressure forces the venom gland to empty up the narrow duct, and venom and glandular tissue spurt (small arrows) into the deep tissue of the foot.

Reproduced from Sutherland K. "Australian Animal Toxins: the creatures, their toxins and care of the poisoned patient." Oxford University Press. Melbourne. 1983.

This author's personal observations which were made in warm tropic seas off Queensland and Oman, whilst others were doing his medical work onshore, were that stonefish are almost always sedentary in habit and will move only when disturbed, and then clumsily and with a considerable degree of reluctance. A stingray on the other hand is a fast swimmer which will thereby add the momentum of its body (which may weigh tens of pounds) to the force of the musculature behind its barbed spike.

Considerable mechanical damage can thereby be caused to the unwary human who swims over a large stingray in shallow water, or who accidentally steps on one. The defensive, reflex action of a stingray to such contact is usually a sudden thrust of its tail forward and downwards, driving the spike into the victim (Fig 2).

The violent actions of a stingray spike in human flesh lead to tissue necrosis which summates with the necrotic action of the injected venom, as well as with the effects of bacterial contamination and retained integument from the spike. The end-result of delayed treatment may therefore be extensive tissue loss necessitating skin grafting(1).

It can be appreciated therefore, that in both stonefish and stingray injuries a considerable degree of contamination is present. Sutherland(5), whose knowledge of the subject is encyclopaedic, summarises the situation thus:- "The wounds are potentially contaminated with bacteria, but may contain (in addition) a trail of glandular and integumentary sheath material as well as necrotic tissue."

Pharmacology of Stone Fish and Stingray Venoms

Laboratory work on stingray and stone fish venoms has not been comprehensive, although a stonefish antivenom has been developed by Commonwealth Serum Laboratories in Australia(5). All fish venoms have been shown to be thermolabile at mammalian body temperatures, a fact which many authorities have regarded as proof of the efficacy of a time-honoured mode of treatment of fish envenomations, viz. immersing the affected part in water as hot as the victim can bear.

Stingray (*Urolophus* species) venom has been shown to contain a toxic protein with a molecular weight of approximately 100,000(5). In monitored cats a bradycardia with S-T wave alterations suggestive of ischaemia occurred when *Urolophus* venom was administered intravenously, but neuromuscular transmission was not disturbed. Cats receiving a lethal dose of *Urolophus* venom showed pupillary dilatation, ataxia, salivation, incontinence and collapse. The intravenous lethal dose (LD) of the lyophilised venom was found to be 28mg/kg in mice.(5)

Wiener(6) dissected out stone fish venom glands from live specimens of *Synanceja trachynis* averaging 700 grams in weight and found an average of 6 mg venom per spine. Venom yields per fish ranged from 49 to 88

Fig 2. The mechanism of the Stingray wound and some common Stingrays.

Reproduced from Sutherland K. "Australian Animal Toxins: the creatures, their toxins and care of the poisoned patient." Oxford University Press. Melbourne. 1983.

mg. Regeneration of venom glands and venom is estimated to take three weeks after the gland has discharged(7). Wiener(6) found the LD to be 0.007 mg intravenously and 0.05 mg subcutaneously in mice weighing 15 grams each.

The same researcher(6) went on to show that an injection of 0.17 mg/kg of stone fish venom into an anaesthetized and monitored dog gave transient hypertension and apnoea. Higher doses produced cardiac and respiratory arrest within two minutes. Electrocardiographic changes such as atrio-ventricular block and ventricular fibrillation occurred in monitored rabbits given intravenous stone fish venom(7). Other workers(8) showed hypotension, respiratory distress and muscular paralysis, suggesting a myotoxic property of stone fish venom. The major toxin is a labile protein with a molecular weight of approximately 150,000, and the venom contains a potent hyaluronidase and a capillary permeability factor(9). No effect was shown by the venom on blood clotting nor did it cause haemolysis.

A survey of reports of Commonwealth Serum Laboratories stone fish antivenom(5) revealed that of 267 reports collected over the period 1965–1981, 129

originated in Queensland, 35 in the Northern Territory, 54 in Western Australia and 49 overseas. Eighty-three percent of the cases were males and apart from three persons injured on their arms or their wrists, all stings occurred either on the hands (36%) or feet (63%). This pattern of distribution between hands and feet suggests that many of these stings could have been avoided. The average age of victims was 27 years with four children under the age of 5 years receiving antivenom for the stings. No deaths were reported.

Common Misconceptions

In spite of the larger amount of material on stonefish envenomation which has already been published in print and on film, it is still possible in 1990 for medically qualified authors to publish a letter in the British Medical Journal entitled: "Stone fish bite"(10) dealing with a case of human envenomation which they had managed. The title words "fish bite"(10) inevitably conjure up the image of an injury similar to the bite of a venomous snake rather than the true picture of penetration by the poisonous dorsal spines of the fish.

Sutherland(11) responded to this misconception with a helpful update on the management of these injuries. He includes the interesting fact, that although immersion of the affected part in warm but not scalding water may indeed provide appreciable relief, there is apparently no evidence that this manoeuvre in fact denatures the venom and pain may return immediately when the heat ceases to be applied.

Treatment

In the same letter, Sutherland(11) goes on to emphasize the importance of local, and if necessary, regional anaesthesia in the management of pain produced by stone fish venom. His recommendation of systemic opiates is disputed, at least for initial pain management by an Australian consultant in intensive care who has extensive experience in managing this problem(12).

There is no doubt of the effectiveness of stone fish antivenom in reducing the pain as well as the other local and systemic effects of stone fish envenomation. The antivenom is supplied by Commonwealth Serum Laboratories, Melbourne, as a pure equine F(ab)2 preparation(5). Ampoules contain approximately 2 ml which will *in vitro* neutralize 20 mg of stone fish venom. The antivenom is recommended in all cases except where pain is only moderate, or else where the case has reached medical care (and antivenom) some time after the sting and is clinically improving.

The initial dose of the antivenom depends upon the number of spines which have punctured the skin thus:

- 1–2 punctures, 2,000 units (one ampoule)
- 3–4 punctures, 4,000 units (two ampoules)
- 5–6 punctures, 6,000 units (three ampoules)

by a watcher on the beach who then pulled the drowning victim from the water.

Another case involved an Australian Army Sergeant who died in 1945 of a stab wound to the left fifth intercostal space 1.25 cm wide and 7.6 cm deep which was shown at autopsy to have perforated the left pleural cavity, the pericardium and the left ventricle(4). Here the fatal injury was inflicted in the opaque waters of an open air salt water swimming bath which communicated with the sea. Although the stingray was never actually seen, an exhaustive search revealed no objects in the swimming bath which could have impaled the victim. The coroner's finding was:- "death by haemorrhage (sic) after being struck by a stingray."

Such freak fatalities from encounters with stingrays remained for many years the only cases recorded in the medical literature. In 1989 however two further fatalities were documented. In the first a previously healthy 12 year-old boy died in Queensland six days after sustaining a penetrating chest injury from a stingray spike. Death was a result of cardiac tamponade secondary to venom-induced, localized myocardial necrosis and spontaneous perforation after direct penetration of the right ventricle with injection of venom(16).

The second recent fatality following injury by a stingray occurred on Waya Island, Fiji in November 1989(17). Here death occurred some hours after the victim was stabbed in the thigh by a large stingray whilst scuba diving. The stingray spike divided the femoral artery and death supervened from uncontrollable blood loss, Waya Island being remote from surgical care. In this context older readers of this Journal may recall the name of Pinkley Neofitou aka Newly, a well-known NAAFI manager in the Suez Canal Zone before 1953, and elsewhere thereafter. Sadly, the latter victim was his elder son who, until the accident had been running an extremely successful diving resort thereby following his family tradition of catering for the recreational needs of others.

Conclusion

This short survey of the damage which two types of tropical fish can inflict on humans indicates that the problem should be viewed from two perspectives. Firstly the cause of death or injury given by attendants on the victim, or even on a tombstone is not necessarily correct(1). Secondly the occasional cases of serious injury or death following encounters with these creatures should be viewed against a statistically far larger group of fatal and non-fatal accidents. This group comprises accidents which occur due to road traffic whilst travelling to the coast, or else are caused through drowning whilst bathing or diving or being involved in a boating accident.

Nevertheless dive-leaders and doctors to Service diving expeditions should be aware of the small but significant danger which both stone fish and stingrays pose in tropical and subtropical waters, and of the first-

Fatalities following human encounters with stingrays have included a stab wound to the pericardium and left ventricle in a previously fit adult woman who swam over a large stingray in shallow water off a beach in New Zealand in 1938(4). A fin of the fish responsible was seen

aid measures needed to counter the biochemical and mechanical effects which these fish can cause in man.

The old adage of prevention being better than cure is nowhere more apt than in encounters with poisonous creatures of any type. Recognition and avoidance will prevent virtually all encounters with these fish from being anything more than the basis of a good story when the diver returns to shore.

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