Case Report

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Finger Flexor Tenosynovitis From Stonefish Envenomation Injury

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Abstract

This case illustrates the challenges in the diagnosis and treatment of chronic tenosynovitis caused by stonefish envenomation injury. Persistence of symptoms can be secondary to an indolent infection, retained micro-foreign bodies, or persistence inflammatory response to verrucotoxin. Successful treatment was obtained with serial debridement coupled with a prolonged antibiotic regimen for coverage of the marine base pathogens.

Level of Evidence: Level IV

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Tenosynovitis refers to a well-localized inflammation of a tendon and its synovial sheath, occurring commonly in the hand and wrist.[1-3] Whereas acute tenosynovitis commonly occurs via direct inoculation, IV drug use, or overuse, chronic tenosynovitis is less commonly caused by envenomation injuries.[2]

Envenomation from marine life is an injury risk for those participating in aquatic activities in the Pacific islands. Stingrays, spine fish such as the stonefish and lionfish, sea urchins, sponges, and octopuses are common culprits for envenomation injuries.[4] The stonefish, *Synanceia verrucosa*, is one of the more venomous fish to be found in the Pacific basin (Figure 1). The fish's vernacular name derives from its mottled brown-green pattern, giving it the ability to camouflage itself among stones and corals. Swimmers in shallow water may inadvertently step on or grab the fish, triggering an envenomation injury. Stonefish are equipped with a venom apparatus that transmits venom originating in the paired glands lying in the two lateral grooves at the base of each spine when mechanical pressure is applied.[5] The dorsal spine's verrucotoxin acts on beta-adrenergic receptors and induces a cascade of histamine and catecholamines release.[4,6-8]

Stonefish injuries acutely cause tissue necrosis, sloughing, and severe pain. The pain increases in the first 1 to 2 hours and can last as long as 12 hours.[4,7] More serious but less common complications include arrhythmias, peripheral neuropathy, seizures, respiratory distress, and muscle paralysis.[5,6] Rarely can the symptoms persist for months after injury secondary to retained foreign bodies or due to an indolent infection from marine pathogens such as *Mycobacterium marinum*.[9]

Case Report

A 30-year-old, healthy, immunocompetent, experienced male diver initially presented on the Pacific island of Guam with pain and swelling of his left ring finger immediately after a sting injury from a stonefish. He sustained the injury while snorkeling. The patient experienced an

Figure 1

Surgical findings of granulomatous inflammation with tissue necrosis. Photograph of a Stone Fish, *Synanceia verrucosa*. Published with permission from the Waikiki Aquarium, University of Hawaii. Honolulu, Hawaii.

Figure 2

Intraoperative photograph of index surgical debridement of the flexor tendon sheath.

acute localized inflammatory reaction to the envenomation injury. He was treated with a combination of oral prednisone, topical corticosteroid, topical antibiotic, and diphenhydramine. His symptoms resolved over the course of 1 week.

The patient re-presented to his primary care physician 6 months after the initial envenomation injury, at which time he endorsed 3 months of insidious onset pain and swelling isolated to the left ring finger. His physical examination was significant for fusiform swelling, tenderness along the flexor tendon sheath, and limited extension of the left ring finger. The skin was intact without erythema. Radiographs of the left hand revealed no acute osseous abnormalities, no retained foreign bodies, or evidence of osteomyelitis. Laboratory evaluation revealed a white blood cell count of $5.0 \times 10^{3}/\mu L$, an erythrocyte sedimentation rate of 13 mm/hr, and a C-reactive protein of less than 0.5 mg/dL. Concerned for an indolent marine infection, he was started on a 30-day course of ciprofloxacin and doxycycline.

His symptoms remained unimproved after antibiotics completion. What was now determined to be a recalcitrant chronic flexor tenosynovitis, the patient underwent surgical irrigation and debridement of the left-hand ring finger flexor tendon.

Surgical findings were significant for extensive, chronic-appearing synovitis affecting both superficial and deep flexor tendons. Gelatinous, purulent material was found along the flexor tendon sheath from the level of the distal interphalangeal joint to the distal palmar crease (Figure 2). Tissue specimens of the synovial sheath were cultured for acid-fast bacilli, fungus, aerobes and anaerobes, and Gram stain. Additionally, a polymerase chain reaction (PCR) assay for nontuberculous mycobacteria (NTM) was completed. However, no causative organism was isolated from the surgical wound. The patient was placed on a course of levofloxacin and doxycycline for presumptive *M marinum* infection.

The patient's symptoms failed to improve after the index irrigation and debridement. He required an additional three surgical debridements over the course of the next 8 weeks until clinical improvement was obtained. Subsequent Gram stains and surgical cultures from each surgical debridement failed to demonstrate any organisms. At the recommendation of an infectious disease consultant, with final cultures negative despite the prolonged incubation period of 12 weeks, antibiotics were discontinued on postoperative day 1 of the fourth and final surgery.

At the final follow-up, 6 months after index surgery and 13 months after the injury, the patient was asymptomatic. Final physical examination revealed that extension/flexion of the left ring finger was measured in degrees as follows: Metacarpal Phalangeal Joint (MCPJ), 0/95; Proximal Interphalangeal Joint (PIPJ), 15/110; Distal Interphalangeal Joint (DIPJ), 0/75. He remained on activity duty status without limitations and without residual swelling.

Discussion

The potential etiologies of chronic flexor tenosynovitis of the hand include infections, autoimmune disorders, gout, pseudogout, calcific tenosynovitis, amyloidosis, ochronosis, stenosing tenosynovitis, and foreign bodies[2] Envenomation injuries resulting in chronic tenosynovitis are exceedingly rare and limited to case reports in the literature.[10,11] Animal species previously implicated in these type of cases include rattlesnakes, catfish, and stingrays.[10-13] In a few of the cases, envenomation wounds have been complicated by retained spines or atypical bacteria leading to an indolent infection.[10]

The *Scorpaenidae* are a large family of venomous marine fish, one of which is considered the most poisonous fish in the world, the stonefish (*Synancei* spp.).[14] Most of these creatures are confined to the Indo-Pacific oceans. The range of habitation includes many popular tropical travel destinations.[15] In more recent years, an increasing incidence of spine envenomation injuries has been observed among home aquarists

handling pet scorpaenids and among chefs preparing scorpaenids for culinary consumption.[14]

The venom consists of four biologically active factors: hyaluronidase fraction, capillary permeability factor, toxic fraction, and a pain-producing factor. As a whole, the venom is an unstable, heat-labile, high molecular weight protein with both myotoxic and neurotoxic properties.[16] Acute manifestations are characterized by intense pain at the wound site, erythema, ecchymosis, lymphedema, and paresthesias. However, chronic symptoms of the venom manifest as slowly healing ulcers at the wound site, continuing allodynic manifestations, and joint contractures. Late complications may include secondary infections, foreign body granulomas, and peripheral neuropathies.[15]

First-line treatment of scorpaenid envenomation should include immediate immersion of the affected extremity in nonscalding hot water of up to 45°C for 30 to 90 minutes to inactivate the heat-labile components of the venom.[15-17] Grossly contaminated or infected wounds should be cultured, and the use of a special culture media for *Vibrio* species or acid-fast stains for marine aquatic mycobacteria should be considered.[10,18,19] Antibiotics are recommended for marine envenomation wounds of the hand or foot due to the high incidence of ulceration, necrosis, and secondary infection.[15] Commonly, patients sustaining envenomation injuries to the hand demonstrate complete resolution of symptoms within 1 to 2 weeks and may require an average hospital admission stay of 4 days.[15-17]

Infection can be a serious long-term complication of marine penetration injuries. A variety of organisms has been reported to be associated with marine envenomation injuries, such as *Klebsiella*, *Erysipelothrix*, *Nocardia*, *Chromobacterium*, *Sporothrix*, *Actinomyces*, *Edwardsiella*, *Mycobacterium*, *Aeromonas*, and *Vibrio* species.[10,19] Of specific concern in salt water injuries are atypical mycobacteria, which have been associated with chronic infections of the hand and wrist synovial tissues and tendon sheaths.[14,18,19] The most common pathogen is *M marinum*, which is an NTM. In many of these cases, presentation of infectious symptoms is often delayed and preoperative laboratory results related to inflammatory reactions can be within normal limits.[10,11,19]

Diagnosis and definitive treatment are aided by tissue biopsy and culture. Acid-fast–stained smears can detect NTM infections; however, the detection rates are highly dependent on the number of organisms present per volume of the tissue, ranging from 0% to 60%.[19] Histopathologically, the epithelioid granuloma is the classic finding indicative of a mycobacterial infection, but granuloma formation is not always present nor is it pathognomonic for NTM as it has been demonstrated in some other disease processes.[18,19] Although difficult to obtain, successful isolation of *M marinum* requires soft-tissue samples to be incubated at two temperatures for 12 weeks.[19] Even with prolonged culture incubation, pathologic tissue examination has been reported to identify *M marinum* as low as 37% of the time.[18] PCR assays can be used to detect NTM species. Recent in vitro studies have demonstrated PCR's ability to detect as little as 50 fg of *M marinum* DNA, which corresponds to approximately 10 mycobacteria, a level 1,000 times more sensitive than microscopic detection of acid-fast organisms.[10,20]

The rates of the surgical necessity for NTM infections of the hand approach 100%.[18] Additionally, multiple surgeries are often required for the eradication of invasive infections, with up to seven repeat surgeries reportedly required for a single patient.[18] Patients should always be counseled on this possible need for multiple surgeries at the time of diagnosis.

Empirical broad-spectrum antibiotics for a marine puncture wound should include coverage for *Vibrio*, *Aeromonas*, *M marinum*, and *Erysipelothrix rhusiopathiae* species. An empirical regimen includes doxycycline in combination with a fluoroquinolone or ceftazidime and clindamycin for the initial 48 hours, followed by an additional week of Augmentin and doxycycline.[10,15] If an overt infection exists, the antibiotic regimen should be based on culture sensitivity results.[15] If *M marinum* has been identified as the infectious agent, a two- or three-drug regimen may be used and anti-tuberculous drugs such as ethambutol or rifampin should be considered. The duration of antibiotic therapy ranges from 3 to 6 months when adjunctive surgical therapy has been performed.[18,19]

Stonefish envenomation injuries present a unique medical challenge for physicians. Initial treatment should be focused on the acute envenomation toxicity, followed by empiric prophylactic antibiotics tailored to a marine bacterial profile. Should a delayed secondary infection arise, the physician needs to maintain a high level of suspicion for an NTM species as the causative agent. Invasive infections may require a combination of a serial surgical debridement and a multidrug antibiotic regimen.

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