Stingray Poisoning, A Careless Aspect in México

Héctor Gabriel Ramos Rodríguez, Edgar Cedillo Sánchez, José D. Méndez

Introduction

Every time we enter the beaches or rivers, we invaded an environment that belongs to aquatic organisms.

The only fact of feeling strange being in their environment, during fishing, scuba diving or scattering (bathers), it can mean for some the need to defend themselves[1,2]. The attack of some of them generally takes place when we touch them accidentally or for their manipulation in the aquariums[3,4]. The sting or bite of marine animals is defined as the poisonous injury provoked by any type of marine life, most of them presenting themselves in salty environments and they could be even, deadly[1]. The stingrays poisoning is named “Rayism”[5], and classified in CIE-10 with the key W56, traumatic contact with marine fauna[6].

Among the marine fauna associated with injuries to humans we can mention the jellyfish, the Portuguese of war man, the stingray, the frogfish, the sea anemone, the sea long spine urchin, the scorpion fish, the catfish, corals, the cone shell, the moray eels, sharks, the barracudas and the electric eels, to mention the most common ones. The stingrays, are animals that we find along our coasts, they rather like slightly deep sandy funds where they stay still, they are not aggressive but in the case of any member of the pastinaca, if they feel threatened, they can shake their tails stinging their spines, that it doesn’t contains a toxin but also can produce tearing of the skin[1,7]. The stingrays with sting live in the Atlantic, Indian and Pacific Ocean.

The fear to stingrays increased after the accidental death (2006) of the popular wildlife expert Steve Irwin, who lost his life when a stingray stung it sting in his thorax[8]. Nevertheless, the accidents with stingrays are unusual, in México (2008) the medical municipal services reported more than a hundred stung bathers in Mazatlán, Altata y El Maviri beaches, in the last one the most number of cases with more than 60 cases in 3 days[9]. In the Cortés Sea there are several kinds of stingrays which the ones that stand out are: Urolophus maculatus (“round” stingray), Urolophus concentricus (“bullseye” stingray), Dasyatis brevis (“whiptail” stingray), Gymnura marmorata (“butterfly” ray), and Myliobatis californica (“bat” ray), among others (10). In map 1 we describe the geographical distribution in the Mexican coasts.

General Aspects and Taxonomic Classification

The stingrays of the northern hemisphere belong to the Dasyatidae family[7,11]. Most of them are not poisonous, but there are 5 poisonous families[2].

Corresponding Author:

Dr. José D. Méndez, 21st Century National Medical Center, Mexican Institute of Social Security, P.O. Box A-047, Mexico City, D.F., Mexico C.P. 06703
Tel.: +52 55 5627 6900 ext. 21561, Fax: +52 55 5227 6109
E-mail: mendezf@servidor.unam.mx
Urolophidae, Dasyatidae and Myliobatidae are considered among the most dangerous (Table 1)[5,12]. They have a whip shaped tail in which base there is a swing or a harpoon composed by dentine with a tegumentary case dentin shaped, saw profile and poisonous glands in the cuneiform area of the tegument[2,13]. The pastinaca (ray with sting), of sweet and salted water in the temperate zones of the planet, has one or more poisonous thorns[14 -16]. The danger of these poisonous animals lies in the inoculation of the poison can cause intense pain even death, if it affects critical zones such as face, thorax and abdomen[15]. It is a cartilaginous fish with a dorsumventral compressed rounded body, cyndrical and elongated tail with an olive grey or green coloration and a length up to 60 cm (Figure 1)[17]. In the low surface of the head it presents two modified teeth, and cutting long plates too[11].

The poison can be found in one or any of the stingrays (Figure 2), and a length up to 30 cm, that it presents in the posterior part of the tail, covered by gelatinous rapping and ventral-laterally placed poisonous bags or bladders[18-20]. The animal moves its tail up and forward and, in that way, sticks its appendages in to the body victim breaking the structure that covers them and its poison is liberated. Most of the injuries happen in the extremities[3,11,18]. The most number of accidents have been reported on the southern coast of California (Urolophus halleri), Gulf of California, Gulf of México and the south coast of the Atlantic Ocean[21]. Nevertheless, there is knowledge of fatal cases and recoveries by thoracic perforations in New Zealand (1938), Australia (1945), Queensland (1969), and

Table 1: Taxonomic classification of the stingray.

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Animalia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phylum</td>
<td>Chordata</td>
</tr>
<tr>
<td>Class</td>
<td>Chondrichthyes</td>
</tr>
<tr>
<td>Subclass</td>
<td>Elasmobranchii</td>
</tr>
<tr>
<td>Superorder</td>
<td>Batoide</td>
</tr>
<tr>
<td>OrderRajiformes</td>
<td></td>
</tr>
<tr>
<td>Families</td>
<td>Acantanthobatidae, Dasyatidae, Gymnuridae, Hexatrygonidae, Myliobatidae, Plesiobatidae, Potamotrygonidae, Rajidae, Rhinobatidae, Urolophidae</td>
</tr>
<tr>
<td>Australia</td>
<td>(“Australian bull” ray; Myliobatis australis), and Florida (2006)[22,23].</td>
</tr>
</tbody>
</table>

The poison and its biochemical composition

The poison is characterized by a protein soluble and thermo labile toxin[11]. It contains serotonin, 5'-nucleotidase and phosphodiesterase, what gives place to immediate and intense pain that lasts up to 48 hours, due to the fact that the first causes intense contractions of the smooth muscle and the others induces degradation and tissue necrosis[19,24,25]. In the poison of P. orbignyi, the peptide name Optrin was isolated that causes vasoconstriction and which sequence of amino acids is His-Gly-Gly-Tyr-Lys- Pro-Thr-Asp-Lys, aligned by creatine kinase residues in 97-105, without any similarity with another bioactive peptide (Table 2) [26]. The amount of nitrogen, carbohydrates and proteins in 100 mg of poison are 3.1 mg, 3.3 mg and 24.9 mg, respectively[21]. The poisons of the P. scobina and P. orbignyi, induce edema forming and nociceptive response in mice. Both diminish when incubate at 37° or 56° C, observing the increase of leucocytes and cells adhered to the endothelium of the crenaster muscle of the rodents. Likewise, it induces necrosis without hemorrhage. Nevertheless when the poisons are inoculated together with the mucous secretion, the necrotizing activity is more vigorously[27]. When there is hemorrhagic necrosis, the infiltrate of lymphoid cells corresponds to CD3+ y CD4+, which suggests that an immunological reaction can contribute to the delay in the healing of the wounds[28]. The P. falkneri poison presents components of 12-15 kD and just one of 84 kD had hyaluronidase activity (many components with over 80 kD and 100 kD molecular mass have gelatinolytic and caseinolytic activity, respectively)[29]. The embryos and adults toxin of P. scobina have gelatinolytic, caseinolytic, fibrinogenolytic, edema forming and nociceptive activity, similar among the 89 y 210 kD components, processes not induced by metalloproteinases. Not present hyaluronidase activity[30]. The P. falkneri and D. guttata ones prove to be similar patterns 80 kD. In mice, only lethal, dermonecrotic and myotoxic activity was detected with P. falkneri poison. The edema forming activity is similar and dose dependent in both poisons, without hemolytic and coagulating response. The nociceptive action is two times bigger in P. falkneri. Present gelatinolytic, caseinolytic and fibrinolytic activity. Only in P. falkneri the presence of hyaluronidase has been observed[31].

Experimentally, it has been demonstrated that 1ml of M. californicus anti poison neutralize the lethal capacity of 10mg of the bat Eagle ray toxin; but it provides almost any protection against the U. halleri toxin. Likewise, 1 ml of U. castexi anti poison neutralizes the lethal action of 5 mg of its toxin. This indicates that exist certain crossed
Table 2: Antibiotics used in the treatment of uncomplicated infections and wound prophylaxis. Empiric antimicrobial therapy must be comprehensive and should cover all likely pathogens in the context of the clinical setting[11].

<table>
<thead>
<tr>
<th>Drug Name</th>
<th>Description</th>
<th>Adult Dose</th>
<th>Pediatric Dose</th>
<th>Contraindications</th>
<th>Interactions</th>
<th>Pregnancy</th>
<th>Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levofloxacin (Levaquin)</td>
<td>First line for infections caused by <em>Vibrio</em> species found in saltwater. Indicated for <em>Staphylococcus aureus</em> and infections caused by multidrug resistant gramnegative organisms.</td>
<td>250-500 mg PO qd for 5 d</td>
<td>&lt;18 years: Not recommended</td>
<td>Documented hypersensitivity</td>
<td>Antacids, iron salts, and zinc salts may reduce serum levels; administer antacids 2-4 h before or after taking quinolones; cimetidine may interfere with metabolism of quinolones; levofloxacin reduces therapeutic effects of phenytoin; probenecid may increase levofloxacin serum concentrations; may increase toxicity of theophylline, caffeine, cyclosporine, and digoxin (monitor digoxin levels); may increase effects of anticoagulants (monitor PT)</td>
<td>C - Safety for use during pregnancy has not been established.</td>
<td>In prolonged therapy, perform periodic evaluations of organ system functions (e.g., renal, hepatic, hematopoietic); adjust dose in renal function impairment; superinfections may occur with prolonged or repeated antibiotic therapy</td>
</tr>
<tr>
<td>Cefixime (Suprax)</td>
<td>By binding to one or more of the penicillin binding proteins, it arrests bacterial cell wall synthesis and inhibits bacterial growth. An advanced-generation cephalosporin. Advantages include once-per-day dosing schedule and broad spectrum. A disadvantage is relatively high cost.</td>
<td>400 mg/d PO qd or divided q12h for 5 d</td>
<td>&lt;12 years: 8 mg/kg/d susP PO qd or 4 mg/kg bid &gt;50 kg or &gt;12 years: Administer as in adults</td>
<td>Documented hypersensitivity</td>
<td>Coadministration with aminoglycosides increases nephrotoxicity; probenecid may increase effects of cefixime</td>
<td>B - Usually safe but benefits must outweigh the risks.</td>
<td>Adjust dose in renal impairment</td>
</tr>
<tr>
<td>Doxycycline (Bio-Tab, Doryx, Vibramycin)</td>
<td>Inhibits protein synthesis and, thus, bacterial growth by binding to 30S and, possibly, 50S ribosomal subunits of susceptible bacteria. Covers <em>Vibrio</em> species well, although coverage not as good for <em>Staphylococcus</em> and <em>Streptococcus</em> species. Generic versions are inexpensive.</td>
<td>25-50 mg/kg/d PO qd; not to exceed 3 g/d</td>
<td>&lt;8 years: Not recommended &gt;8 years: 2.5 mg/kg/d PO in 1-2 divided doses; not to exceed 200 mg/d</td>
<td>Documented hypersensitivity</td>
<td>Bioavailability decreases with antacids containing aluminum, calcium, magnesium, iron, or bismuth subsalicylate; tetracyclines can increase hypoprothrombinemic effects of anticoagulants; tetracyclines can decrease effects of oral contraceptives, causing breakthrough bleeding and increased risk of pregnancy</td>
<td>B - Usually safe but benefits must outweigh the risks.</td>
<td>Adjust dose in renal impairment</td>
</tr>
<tr>
<td>Trimethoprim and sulfamethoxazole (TMP-SMZ, Bactrim, Septra)</td>
<td>Inhibits bacterial growth by inhibiting synthesis of dihydrofolic acid. Inexpensive combination agent that covers <em>Vibrio</em> and some <em>Staphylococcus</em> and <em>Streptococcus</em> species. As with doxycycline, many individuals can develop photosensitive skin rashes while on the medication. (This is important if the patient is on vacation or lives at the beach and is likely to get significant sun exposure while on the medication.)</td>
<td>1 DS (double strength) tab PO bid or 2 regular strength tab PO bid or 20 mL susP PO bid for 5 d</td>
<td>&lt;2 months: Not recommended</td>
<td>Documented hypersensitivity</td>
<td>Photosensitivity may occur with prolonged exposure to sunlight or tanning equipment; reduce dose in renal impairment; consider drug serum level determinations in prolonged therapy; tetracycline use during tooth development (last one-half of pregnancy through age 8) can cause permanent discoloration of teeth; Fanconi-like syndrome may occur with outdated tetracyclines</td>
<td>D - Unsafe in pregnancy</td>
<td>Photosensitivity may occur with prolonged exposure to sunlight or tanning equipment; reduce dose in renal impairment; consider drug serum level determinations in prolonged therapy; tetracycline use during tooth development (last one-half of pregnancy through age 8) can cause permanent discoloration of teeth; Fanconi-like syndrome may occur with outdated tetracyclines</td>
</tr>
</tbody>
</table>
>2 months: 8-12 mg/kg/d PO based on TMP divided bid (40 mg/5 mL susp)

**Contraindications**
Documented hypersensitivity; megaloblastic anemia because of folate deficiency; pregnant women at term and breastfeeding women (sulfonamides pass through placenta and are excreted in breast milk, which may cause kernicterus)

**Interactions**
May increase PT when used with warfarin (perform coagulation tests and adjust dose accordingly); coadministration with dapsone may increase blood levels of both drugs; coadministration of diuretics increases incidence of thrombocytopenia purpura in elderly persons; phenytoin levels may increase with coadministration; may potentiate effects of methotrexate in bone marrow depression; hypoglycemic response to sulfonamide may increase with coadministration; may increase levels of zidovudine

**Pregnancy**
C - Safety for use during pregnancy has not been established.

**Precautions**
Discontinue at first appearance of rash or sign of adverse reaction; obtain CBCs frequently; discontinue therapy if significant hematologic changes occur; goiter, diuresis, and hypoglycemia may occur with sulfonamides; prolonged IV infusions or high doses may cause bone marrow depression (if signs occur, give 5-15 mg/d leucovorin); caution in folate deficiency (eg, chronic alcoholic persons, elderly individuals, those receiving anticonvulsant therapy, or people with malabsorption syndrome); hemolysis may occur in G-6-PD deficiency; AIDS patients may not tolerate or respond to TMP-SMZ; caution in renal or hepatic impairment (perform urinalyses and renal function tests during therapy); give fluids to prevent crystalluria and stone formation

---

**Fig. 1:** Body plan of a Whiptail Stingray (Family Dasyatidae) (20).

**Fig. 2:** Dorsal view of tail spines from a female D. Sabina (Fishes of the Western North Atlantic, 1948)[20].

**Fig. 3:** Algorithm for the attention of a stingray poisoned patient.
protection among these biological[32]. The intravenous LD50 of lyophilized poison estimates in 28.0 mg/kg[21].

Of less to more poisonous, they are: Gymnuridae, Myliobatidae, Dasyatidae y Urolophidae.

**Medical Condition**

The sting of the stingray represents poisoning and traumatic wounds, characterized by a puncture or hemorrhagic painful lacerations, due to the fact has a saw shape with sudden movements it can produce more extensive damage in deep tissues (Figure 3)[13,16,33]. A sting smaller than 5mm of width produces a wound of 3.5 cm of length and a bigger one produces a laceration up to 18 cm[21]. The sharp pain increases and spreads regionally during the posteriorly 30-60 minutes, being able to persist up to 48 hours[2,12]. The wound present edema forming, cyanosis, local erythema, petechiae. The ulceration and the local progressive necrosis are variable and often tend to become infected, become gangrenous or become chronic (Figure 5)[2,13,28]. The signs and symptoms can be qualified in two groups: a) Located: pain, burning, inflammation, reddening and hemorrhage, y b) Generalized: inguinal and/or axillary pain, migraine, fever, cramps or muscular spasms, diaphoresis, breathing difficulty, anxiety, widespread paleness, rash, delirium, weakness, dizziness, respiratory distress, nausea, vomiting, diarrhea, sialorrhea, paresthesia, paralysis, convulsions, hypotension or hypertension, syncope and systemic serious reactions (respiratory arrest, heart rhythm disorder, shock, etc) in sensitive or allergic persons to the inoculated poison and, in infrequent cases, the death of the patient[1,14,24]. Small quantities of toxin produce transitory vasodilatation. In the ECG bradycardia is observed with an increase in the PR interval, demonstrating a first degree A-V blockage. A big amount produces arteries, veins and arterioles to constrict and a second and third degree A-V blockage. Besides the PR changes, alterations are observed in ST and wave T that are ischemia indicative. The neuromuscular conduction is not affected[21]. In case of injury in highly vascularized zones (neck) there can be arrhythmias and even death[1,3,7]. In severe cases (penetration of the thorax, abdomen or groin), it should be considered an urgency and get to a hospital center immediately (Figure 3)[13,16,33].

In many cases the sting or the thorns fractured and remain logged in de wound, moving along the risk of secondary infections[15,18]. The isolation of opportunist is common such as Escherichia coli and Proteus spp, among others[5].

At the moment of assessment the severity of a sting, it is necessary to consider several aspects such as: 1. **Agent:** Kind of stingray that produces the sting (important its identification), 2. **Zone or Region:** where the injury takes place. 3. **Characteristics of the injured one:** age, allergies, state of health, etc. and 4. **Environment:** There is or not immediate sanitary assistance, possibility of evacuation potential activity risk far away from the coast, etc.

**Diagnosis**

The lab studies are not indicated in cases where the animal is identified. The x-rays at least in to planes, are useful to identify the presence of foreign bodies like sting fragments[11]. In the ECG we can appreciate flat and two phase T waves. The penetrating wound in the thorax, at cardiac level, must be evaluated by means of an ECG to determinate the presence of pericardial effusion or tamponade. In case of myocardial penetration, determinate cardiac enzymes (CK), which rise in the first 8 hours[13,22].

**Therapeutic managing**

The treatment of marine fauna poisoning is similar to the bites of poisonous snakes, in the means that most of the applied measures have the nature of support or maintenance. Whenever it is necessary to use specific marine antidotes[24].

Keep the victim as calm as possible, to immobilize the affected extremity and remove the sting fragments with glove or towel[1,12]. When there is contact with the skin and mucous, wash with abundant salty water[1,14]. Introduce the injured extremity in warm water (43-45° C) during 40 to 90 minutes (the poison is thermo labile), or until important relief is produced. The cryotherapy is contraindicated. Use analgesics (meperidine)[12,24], local anesthetics, muscle relaxants, antihistamines, and corticoids for the pain, itching and swelling, respectively[1,14]. Update or initiate antitetanic prophylaxis. Prescribe antimicrobial therapy in case of serious wounds, secondary infections and immunosuppressed patients.

The initial regiments must Staphylococcus y Streptococcus (12, 36). Before the presence of the salty water kinds of Vibrio, sweet water Aeromonas
and Mycobacterium marinum, there are useful the quinolones (ciprofloxacin, levoflaxacin), doxycycline, trimetroprim/sulfamethoxazole, ceftriaxone, mupirocin, ceforoxime, aminoglycosides or chloramphenicol. A short regimen of prophylactic treatment is suggested taken by mouth for 5 days (Table 2)[11,12,24]. The opiates (oral or parenteral) as well as his local infiltration of the wound or regional nerve blocks with lidocaine at 1% bupivacaine at 0.5% and baking soda mixed 5:5:1 proportion, help to control the pain and minimize the tissue necrosis[10,13,24].

The adrenaline is counter indicated[22]. After the hot water soaking and after the anesthetic administration, the wound should be explored and debrided[18,24]. There is not a specific antidote[11].

It has been used a vinegar or meat softening solution to neutralize the poison[1]. The hyperbaric oxygen has given beneficial results. The absorption of the toxin can be accomplished with calcium alginate[23].

Within the counter indications we find: to never apply turnstiles nor compressive bandages, not to try or withdraw the stings without the due protection in the hands, do not raise above the cardiac level the affected area, do not administer any medication without the medical or qualified personnel authorization and avoid any movement on the part of the victim[1].

If the wound present torpid evolution, surgical split it is indicated[12]. The x-ray can be useful for the identification and location of foreign bodies. After the debridation and exploration of the wound must be vigorously irrigated with sterile war water, SSF, povidone-iodine in solution at 1 % or Hexachlorophene in alcohol at 70 %[23]. Unless is indispensable the immediate closing because of the hemostasia, the wound must remain open for second intention or its primary retarded[24] Table 2. Antibiotics used in the treatment of uncomplicated infections and wound prophylaxis. Empiric antimicrobial therapy must be comprehensive and should cover all likely pathogens in the context of the clinical setting[11].
Table 3: Biochemical venom composition and its mechanism of action.

<table>
<thead>
<tr>
<th>SUBSTANCE</th>
<th>FORMULA</th>
<th>OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyaluronidase</td>
<td>HGNYKPTDK (1002 Da)</td>
<td>Hydrolyses the hyaluronic acid of the extracellular matrix (diffusion factor). With antigenic properties.</td>
</tr>
<tr>
<td>Serotonin (5-hydroxytryptamine or 5HT)</td>
<td></td>
<td>Affects vascular operation (severe vasoconstriction). Severe contact of smooth muscle, painful.</td>
</tr>
<tr>
<td>5'-nucleotidase</td>
<td></td>
<td>Exonuclease. It breaks the last nucleotide of the end of polynucleotide. It can degrade a linear nucleic acid completely. Promolytic activity.</td>
</tr>
</tbody>
</table>

Prognosis

In general the stingray provoke injuries (twinges, wounds, lacerations, poisonings) have good evolution if the patient does not develop infections or other complications, they can present pain for 21-18 hours and 1 or 2 weeks recovery[11].

Prevention and control

In case of meeting these animals, move away from the place[7]. Use special made beach shoes. This not only will protect you against marine fauna, but also against Sharp objects (cans, broken bottles, etc.). Swim near the life-guard and in safe areas. Avoid the immersion where there are signs of the presence of poisonous or dangerous animals. Do not touch dead or unknown; the first ones can still contain poison in its body[1]. Try not to walk along tropical rivers shore waters, or slightly deep beaches, and if you do, move the sand with a stick before you step on it, because the stingrays are difficult to see because they hide or camouflage in the[15]. Most of the cases appear on summer months; particularly in August. 54 % of the accidents happen in public areas, mainly in tropical and subtropical coasts[4,37].

In case of fishing, inspect the nets; avoid contact with potential poisonous kinds[3]. If you scuba dive, do not think that these animals are inoffensive and do not provoke them without need[7]. It is known that the sting penetrate the neoprene, leather, and rubber. The sandals and tennis do not eliminate the possibility of injuries[10].

Conclusions and recommendations

Though the accidents with stingrays are considered sporadic or isolated, but they happen to bathers in slightly deep waters, in immersions in the beach, in aquariums, during fishing and in unexpected situations as the thoracic perforations commented ones that ended with some people lives. Due to the wide distributions of some of the genres in Mexican littorals, the attention of an important number of cases, in some beaches and the record of the death of a person whiptail stingray attack in the Cortés Sea[10], suggest the following considerations:

a) Nevertheless that the stingrays are sporadic and in an accidental ways, it must be considered potentially dangerous due to its geographical distribution and the great variety of kinds in Mexican littorals,

b) Respect the signs about the presence of poisonous or dangerous animals and use implements to avoid accidents,

c) In case of stingrays injuries, try to identify the involved specie, apply first aids and request medical valuation as soon as possible with the intention to avoid serious complications. Do not self-medicate,

d) Avoid these animals manipulation if you do not have neither the necessary experience nor the suitable protection equipment,

e) Before visiting any beach consult the inherent risks in the contact with endemic dangerous species, and f) and report to the sanitary authorities the stingray accidents, which allow to consider its epidemiological importance.
Map 1: Geographic distribution of rays of medical importance in the Mexican coasts. For the case of the genus Urobatis, (sp) it involves other species like U. maculatus, U. concentricus and U. jamaicensis. The last one predominates in the Gulf of Mexico and the Caribbean. The population density for each species acquires knowledge.

References

3. Picadura de animales marinos. www.comosalvarvidas.info/content/view/14/79/1/5/
6. Clasificación Internacional de las Enfermedades CIE-10. www.iqub.es/patologia/e20_005.htm
8. Vacaciones seguras: cuidado con las criaturas oceanicas. local.bimedia.net/yftes/news/8393117.html?cat=sufamilia&type=yftesarticle


36. First-Person Report on Diagnosis. science.howstuffworks.com/stingray.htm