

Irukandji-like syndrome caused by single-tentacle box jellyfish found in Thailand, 2007–2019

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ABSTRACT

Background: Irukandji syndrome definition is still widely misunderstood. Irukandji-like syndrome is more unclear than Irukandji syndrome. This study aimed to describe Irukandji-like syndrome in cases involving stinging by single-tentacle box jellyfish species in Thailand.

Materials and methods: Surveillance system and networks of toxic jellyfish incidents were established to enable case detection. In the period 2007 to 2019, all cases of stinging by single-tentacle box jellyfish resulting in collapse, hospital attendance or death were investigated.

Results: The majority of the 19 Irukandji-like syndrome cases were male (68.2%), median age 35.0 years (range 6.0–60.0), and Thai nationality (52.3%). Clinical manifestations of Irukandji-like syndrome were categorised as severe wound pain with immediate systemic reaction (66.7%), moderate wound pain with gradual systemic reaction (16.7%), and moderate wound pain with the immediate systemic reaction after a physical/chemical trigger (16.7%). The pain occurring when being stung differed from the pain occurring during the systemic reaction. The five most common symptoms were pain (100.0%), high blood pressure (100.0%), palpitations (86.7%), respiratory distress (52.6%), and near collapse/collapse (31.6%). The pain occurs when being stung was excruciating or burning pain at the wounds, felt like an electric shock, and rapidly expanded to heart pain. While the pain occurring during the systemic reaction was back pain, muscle pain, joint pain, abdominal pain, and body aches. The marks from the tentacles appeared similar in appearance to the caterpillar tracks of tanks. In 6 cases the species could be identified and all of them involving the *Morbakka* spp.

Conclusions: This was the largest study of Irukandji-like syndrome cases involving stings by single-tentacle box jellyfish in Thailand and the different clinical manifestations might be caused by different species of single-tentacle box jellyfish.

(Int Marit Health 2020; 71, 2: 91–96)

Key words: Irukandji-like syndrome, box jellyfish, envenomation, sign, symptom, definition

INTRODUCTION

The occurrence of box jellyfish envenomation was initially denied in Thailand. In 2008 a medical epidemiologist from the Ministry of Public Health and one from the Faculty of Medicine, Chiang Mai University (author) started to investigate this issue and provided evidence to show the existence of lethal box jellyfish envenomation in Thailand [1–3]. Dangerous envenomation incidents concerning box jellyfish in Thailand have involved both multiple-tentacle and single-tentacle box jellyfish. Multiple-tentacle box jellyfish, *Chironex* spp. have caused fatal and near-fatal cases [4–10]. Single-tentacle box jellyfish stings are known to

cause Irukandji syndrome and Irukandji-like syndrome. Small carybdeid jellyfish, specifically *Carukia barnesi* are considered to be the main cause of Irukandji syndrome [11]. Other Australian carybdeid jellyfish are *Morbakka* spp. and *Morbakka fenneri* [12, 13]. There are at least three unnamed species of single-tentacle box jellyfish known to cause injuries in Thailand. However, it is possible that other species can cause Irukandji-like syndrome with different clinical manifestations [9, 10, 12, 14].

A case definition of Irukandji syndrome has been described as a severe local and systemic reaction occurring after a *Carukia barnesi* box jellyfish sting involving exposed



skin [11]. The symptoms and signs developed between 5 and 40 minutes after being stung. These were predominantly pain and autonomic disturbances, such as severe muscle pain, muscle cramps, vomiting, sweating, agitation, hypertension, and heart failure [15–17]. However, Irukandji syndrome definition is still widely misunderstood, including species causing the syndrome, toxins, and geographic distribution. There had been reports of box jellyfish envenomation presenting as Irukandji syndrome but with other different symptoms and signs [16, 18]. Irukandji-like syndrome is more unclear than Irukandji syndrome. The Irukandji-like syndrome case report that occurred in Victoria was in 1998 [19]. Irukandji-like syndrome was described as: “Other jellyfish species (Not *Carukia barnesi*) cause a similar but not necessarily identical symptom complex referred to as Irukandji-like syndrome” [16]. The first case report of Irukandji syndrome in Thailand was published in 2001, which should have been described as Irukandji-like syndrome [20]. Physicians rarely diagnosed Irukandji-like syndrome in Thailand due to limited knowledge and inadequate laboratory facilities [8]. There is little known about the clinical manifestations of Irukandji-like syndrome caused by single-tentacle box jellyfish found in Thailand. The findings will be useful for diagnosis, health care, surveillance, and prevention and control measures. This study aimed to describe Irukandji-like syndrome associated with cases of stinging by single-tentacle box jellyfish found in Thailand.

MATERIALS AND METHODS

A medical epidemiologist from the Ministry of Public Health (MOPH) and one from the Faculty of Medicine of Chiang Mai University (author) started to investigate whether lethal jellyfish existed in Thailand as long ago as 2007. They established ad hoc toxic jellyfish surveillance in 2009, which later became the National surveillance system. They formed a steering team and invited officers from the Ministry of Natural Resources and Environment to join. This steering team established three toxic jellyfish networks, specifically task forces, experts, and communities. The initial members included Divers Alert Network, experts and health personnel in Thailand and a journalist and experts from universities in Australia. The membership expanded to stakeholders such as resort/hotel managers/owners, divers, speed boat/long-tail boat groups and biologists in order to detect the cases, build knowledge and collaborate regarding strategy. In the period from 2007 to 2019, all cases of stinging by single-tentacle box jellyfish resulting in collapse, hospital attendance or death were investigated. The investigations were conducted under the government service policy of emergency public health problems. These cases were included in this study. Data included details of the incident, physical examination, photographs of the

wound, description of the box jellyfish, and a sample (if available) of the tentacle of the box jellyfish using Vacuum Sticky Tape for Identification of Toxic Jellyfish Class [5, 10]. The same technique was used for the collection and transfer of the tentacle of the single-tentacle box jellyfish from the incident place and for nematocyst identification to determine the class of box jellyfish [5, 10].

Descriptive analyses included proportion, mean \pm standard deviation (SD), or median (minimum, maximum) depending on data distribution. Data management and analyses were performed using Epi Info for Windows version 7 (Centres for Disease Control and Prevention, Atlanta, GA).

RESULTS

INCIDENT BY PERSON, TIME AND PLACE

During the period from 2007 to 2019, 19 cases of stinging by single-tentacle box jellyfish were detected and investigated by the surveillance system. No fatalities were reported. The majority of cases were male (68.2%), with a median age of 35.0 years (range 6.0–60.0 years), tourists (52.3%), and Thai nationality (52.3%). The places where the incidents occurred were located along both coasts of Thailand. The three provinces with the highest reported incidence were Surat Thani (52.6%), Krabi (15.8%), and Trang (10.5%). The median number of incidences was 3 cases per year and the highest incidence was in 2016 (26.3%). About 31.6% of cases were received appropriate first aid (Vinegar poured on the wounds immediately for at least 30 s; Table 1). Among 19 cases, 6 of them could identify species group of single-tentacle box jellyfish. All of them were *Morbakka* spp. (31.6%). All cases had severe wound pain with immediate systemic reaction.

CLINICAL MANIFESTATIONS

Clinical manifestations of Irukandji-like syndrome were categorised into three groups. These were severe wound pain with immediate systemic reaction (66.7%), moderate wound pain with gradually systemic reaction (16.7%), and moderate wound pain with immediate systemic reaction after physical or chemical trigger (16.7%), such as rubbing with sand, taking a bath in freshwater, and rubbing with soap. The duration between the time of sting and pain development varied from a few seconds to a few minutes. The description of pain occurring when being stung included excruciating, burning, electric shock, and heart pain. The pain experienced during the systemic reaction included: headache, back pain, muscle pain, joint pain, abdominal pain, and body aches similar to being stabbed by knives (sharp jabbing pain). The pain was not constant but came in looping waves that increased for a few hours and lasted for 1 to 2 days.

The top five common symptoms and signs were pain (100.0%), high blood pressure (100.0%), palpitations

Table 1. Incident by the person, time, place in 19 Irukandji-like syndrome cases

Characteristics	Frequency	Per cent
Occupation		
Tourist	10	52.3
Fisherman	4	21.1
Jet ski rider	1	5.3
Divemaster	1	5.3
Civil servant	1	5.3
Volunteer	1	5.3
Employee	1	5.3
Nationality		
Thai	10	52.3
British	3	15.8
American	2	10.5
Finnish	1	5.5
French	1	5.5
Dutch	1	5.5
Burmese	1	5.5
First aid		
Appropriate vinegar pouring	6	31.6
No first aid	6	31.6
Inappropriate first aid	6	31.6
Late vinegar pouring	1	5.2
Year of occurrence		
2007	2	10.5
2008	2	10.5
2014	3	15.8
2015	1	5.5
2016	5	26.3
2017	3	15.8
2019	3	15.8
Province		
Surat Thani	10	52.6
Krabi	3	15.8
Trang	2	10.5
Phuket	1	5.3
Petchburi	1	5.3
Stun	1	5.3
Chonburi	1	5.3

(86.7%), respiratory distress (52.6%), and near collapse/collapse (31.6%) (Table 2).

The systemic reaction presented in waves of mild to severe symptoms and signs, including burning pain, headache,

Table 2. Symptoms and signs in nineteen Irukandji-like syndrome cases

Symptoms and signs	Frequency	Per cent
Pain	19	100.0
High blood pressure*	14	100.0
Palpitations**	13	86.7
Respiratory distress	10	52.6
Near collapse/collapse	6	31.6
Fatigue	5	26.3
Nausea or vomiting	5	26.3
Anxiety/agitation	4	21.0
Abdominal cramp	4	21.0
Sweating	2	10.5

*Excluded 5 cases with no record; **Excluded 4 cases with no record

body aches, back pain, muscle pain, joint pain, abdominal cramps, nausea, vomiting, fatigue, paralysed limbs, respiratory distress, palpitation, high blood pressure, sweating, anxiety, and agitation.

WOUND CHARACTERISTICS

All cases had tentacle marks. In all cases, except four with healing wounds when undergoing a physical examination, the marks from the tentacles appeared similar in appearance to the caterpillar tracks of tanks which have articulated steel bands passing around the wheels with repeated interspersions by normal tissue (Fig. 1). The width of the brown erythematous tentacle marks varied (Fig. 1A, B).

Three cases had blisters within 1 day after being stung. One case had sweat on the right hand which had been in contact with box jellyfish tentacles 18.5 hours after being stung and lasted for 2 days (Fig. 2).

DISCUSSION

The actual incidence of cases of Irukandji-like syndrome might be higher than that recorded in this paper. Two of the reasons for this are that health personnel might give a misdiagnosis and cases with mild symptoms might not go to a doctor [7, 14]. However, this study emphasized moderate to severe cases in order to reduce false positive cases. Although the majority of the cases are tourists, fishermen are another vulnerable population that needs consideration and they are active all year round. Many Thais believe that Caucasian people have a hypersensitivity to jellyfish not Thai people [7, 14]. This study found that more than half of the cases were Thai nationals and had clinical manifestation that indicated a non-allergic response to the toxin [2, 7, 14, 21]. The highest number of cases was in the Surat Thani Province in the Gulf of Thailand. Although fatal cases stung by multiple-tentacle box jellyfish were found in this province,



Figure 1. The width of the tentacle marks varied; **A.** Erythematous brownish colour on the second day after being stung by *Morbakka* spp.; **B.** Erythematous colour on the second day after being stung by other species on the left ring finger (image source: Cases)



Figure 2. Sweat appeared on the right hand which had been in contact with box jellyfish tentacles 18.5 hours after being stung (image source: Case)

there was no report of a fatal case stung by single-tentacle box jellyfish [4, 7, 8, 14].

Appropriate first aid for stings by box jellyfish found in Thailand is pouring vinegar (4–6% acetic acid) for at least 30 seconds continuously on the wound immediately after contact with the tentacle (except for stings in the eye) [6–8,

22–24]. In more recent years, stings were treated with vinegar as the intervention measures had been launched. Based on the author’s experiences, severe cases of being stung by box jellyfish who had late vinegar poured on the wounds (as long as 10 to 15 min) after the events survived. Thus, vinegar pouring is recommended for first aid [7, 8, 22–25]. The steering team contributed the results from researches, surveillance, and outbreak investigations to policymakers, which led to prevention and control measures, including vinegar stations and educational warning signs being installed at the beaches [3, 5, 7].

This study showed that the majority of cases experienced severe wound pain with an immediate systemic reaction, while Irukandji syndrome sufferers usually had mild to moderate wound pain with a gradual systemic reaction about 5 to 60 minutes after being stung [16, 26]. Some cases had moderate wound pain with an immediate systemic reaction after physical or chemical triggers (such as rubbing sand or soap into the wound, taking a bath with freshwater). The possible explanation of the immediate systemic reaction might be due to more toxin entering the system due to physical or chemical triggers. It is worth noting that the pain occurring when being stung differed from the pain occurring during the systemic reaction. The pain occurs when being stung was excruciating or burning pain at the wounds, felt like an electric shock, and rapidly expanded to heart pain. While the pain occurring during the systemic reaction was back pain, muscle pain, joint pain, abdominal pain, and body aches. These pains were not constant but

came in waves which increased in a few hours and lasted for 1 to 2 days. Therefore, a clear case definition can help in diagnosis, health care, and advice patients. The clinical manifestations of multiple-tentacle box jellyfish sting found in Thailand usually present with immediate severe wound pain following the stings and do not have waves of increasing pain and loops of systemic reaction [7, 8, 14, 27].

The tentacle marks found in this study appeared as caterpillar tracks of the tank that have articulated steel bands passing around the wheels, which is similar to that of multiple-tentacle box jellyfish [7, 8, 14, 24, 27]. According to the context of Thailand, Thaikruea et al. [7, 24] used caterpillar track appearance in defining Thai language term as “Teen-ta-kab” for risk communication because it is more understandable than other professional’s terms (i.e. “Frost-ladder-like”, “Step ladder-like”, or “Ladder-like transverse band”). The tentacle marks caused by single-tentacle box jellyfish stings often cover a smaller area of skin than those caused by multiple-tentacle box jellyfish stings. However, it is difficult to distinguish between a few tentacle marks caused by multiple-tentacle box jellyfish stings and tentacle marks caused by single-tentacle box jellyfish stings. Thus, a history of exposure and clinical manifestation is important information for diagnosis [27]. Another interesting wound characteristic was blistering. Blisters were reported among severe cases stung by multiple-tentacle box jellyfish found in Thailand [14, 27]. The blisters in these cases developed within 24 to 48 hours among cases with massive stings or incorrect first aid. In some cases, blisters developed on the 4th or 5th day after being stung [14, 27]. In this study, 3 cases had blisters within 24 hours. Possible explanations were probably high doses of toxin due to massive stings (1 case) and incorrect first aid which increased nematocyst firing (2 cases). This finding is useful because blister has been reported only in severe wound complications among cases involving stings by multiple-tentacle box jellyfish [6]. However, only 1 case had deep dermal necrosis and needed wound debridement for about 2 months in this study. Another study reported a delayed development of dermal necrosis in a girl with one of these stings [28]. One case had sweating localised on the skin area which had been in contact with the tentacle of a single-tentacle box jellyfish. Interestingly this sign has not been reported in any cases involving stings by both single and multiple-tentacle box jellyfish found in Thailand.

This study found that the systemic reactions presented in waves of mild to severe symptoms and signs. These symptoms and signs were similar to those of Irukandji syndrome [16, 26, 29]. However, no cases report any feelings of impending doom. They were more likely to experience anxiety or agitation. The common symptoms and signs can be used for determination and diagnosis. In this study, the

top five most common symptoms and signs were pain, high blood pressure, palpitation, near collapse/collapse, and fatigue. Although less common, nausea and vomiting were found in cases involving stings by multiple-tentacle box jellyfish found in Thailand [7, 8, 14, 27]. Based on the author’s experiences, this nausea and vomiting symptoms without taking a history of jellyfish contact and no/unnoticed tentacle mark may lead to misdiagnosis of other possible illnesses such as food poisoning and appendicitis among children.

According to the findings of symptoms and signs related to cardiovascular and respiratory systems, monitoring of vital signs is recommended for treatment assessment and progression. It is worth noting that all cases involving stings by *Morbakka* spp. had severe wound pain with immediate systemic reaction. Fenner et al. [13] reported the first case involving a sting by *Morbakka* spp. which had similar symptoms and signs to the findings in this study. Based on toxic jellyfish networks in the surveillance system, *Morbakka* spp. were found in diving spots in the deeper areas of the sea. In recent years, they have also been found in shallow water near the beach. An outbreak investigation team from MOPH reported *Morbakka* spp. in August 2003 [8]. A new species *Morbakka fenneri* was discovered and identified as a species of Irukandji jellyfish [12]. However, the actual species of *Morbakka* spp. found in Thailand have not yet been identified. To date, they are named as *Morbakka* spp.A, *Morbakka* spp.B, and *Morbakka* spp.C [9]. Different clinical manifestations support the possibility that more than one species of single-tentacle box jellyfish found in Thailand can cause Irukandji-like syndrome. Further studies should be conducted to prove this observation. The location and species of single-tentacle box jellyfish are useful in distinguishing between Irukandji syndrome and Irukandji-like syndrome.

There were some limitations to this study, the species of single-tentacle box jellyfish could not be identified in some cases due to the practical difficulty in catching the jellyfish. Also, the setting up of laboratory facilities for research has only occurred recently. The numbers of cases might be somewhat underestimated due to misdiagnosis or undetected by surveillance in earlier years when there was a lack of Irukandji-like syndrome knowledge. However, the number might have little effect on the findings of this study because the toxic jellyfish networks of the surveillance system cover both coasts of Thailand and communities and stakeholders engaged in the surveillance and interventions [2, 3, 5, 7, 10].

CONCLUSIONS

This is the largest study of Irukandji-like syndrome cases involving stings by single-tentacle box jellyfish in Thailand and the clinical manifestations differ from those of

multiple-tentacle box jellyfish stings. The different clinical manifestations in these cases might be caused by different species of single-tentacle box jellyfish. Clear clinical manifestation is particularly important in this context that communities play a major role in early warning and rapid response. The practical definition will be useful for medical care, surveillance system, and prevention and control measures.

ACKNOWLEDGEMENTS

I would like to express my thanks to Chiang Mai University and the Faculty of Medicine for management support. I would like to thank Dr. Pitikhun Setapura, Dr. Potjaman Siriariyaporn, Miss Hataya Kanjanasombut and Miss Kannika Monpangtiem (Epidemiology Division, Ministry of Public Health) for information

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