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Shark attack-related injuries: Epidemiology and implications for plastic surgeons



Joseph A. Ricci^a, Christina R. Vargas^a, Dhruv Singhal^b,
Bernard T. Lee^{a,*}

^a Department of Surgery, Division of Plastic and Reconstructive Surgery, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, USA

^b Department of Surgery, Division of Plastic and Reconstructive Surgery, University of Florida Health System, University of Florida School of Medicine, Gainesville, FL, USA

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Summary *Background and aim:* The increased media attention to shark attacks has led to a heightened fear and public awareness. Although few sharks are considered dangerous, attacks on humans can result in large soft tissue defects necessitating the intervention of reconstructive surgeons. This study aims to evaluate and describe the characteristics of shark-related injuries in order to improve treatment.

Methods: The Global Shark Accident File, maintained by the Shark Research Institute (Princeton, NJ, USA), is a compilation of all known worldwide shark attacks. Database records since the 1900s were reviewed to identify differences between fatal and nonfatal attacks, including: geography, injury pattern, shark species, and victim activity.

Results: Since the 1900s, there have been 5034 reported shark attacks, of which 1205 (22.7%) were fatal. Although the incidence of attacks per decade has increased, the percentage of fatalities has decreased. Characteristics of fatal attacks included swimming ($p = 0.001$), boating ($p = 0.001$), three or more bite sites ($p = 0.03$), limb loss ($p = 0.001$), or tiger shark attack ($p = 0.002$). The most common attacks were bites to the legs (41.8%) or arms (18.4%), with limb loss occurring in 7% of attacks. Geographically, the majority of attacks occurred in North America (36.7%) and Australia (26.5%). Most attacks in the USA occurred in Florida (49.1%) and California (13.6%).

* Corresponding author. Department of Surgery, Division of Plastic and Reconstructive Surgery, Beth Israel Deaconess Medical Center, 110 Francis St., Suite 5A, Boston, MA 02215, USA. Tel.: +1 617 632 7835; fax: +1 617 632 7840.

E-mail addresses: jaricci@partners.org (J.A. Ricci), christinarvargas@gmail.com (C.R. Vargas), dhruv.x.singhal@gmail.com (D. Singhal), btleee@bidmc.harvard.edu (B.T. Lee).

Conclusions: Although rare, shark attacks result in devastating injuries to patients. As these injuries often involve multiple sites and limb loss, this creates a significant challenge for reconstructive surgeons. Proper identification of the characteristics of the attack can aid in providing optimal care for those affected.

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Introduction

Sharks have both intrigued and terrified society for decades because of increased media attention and thrilling Hollywood drama. America's infatuation with sharks began following the release of the blockbuster movie *Jaws* 40 years ago. Since its debut, the film has had a broad cultural impact and has been criticized by many scientists for fueling negative stereotypes about sharks and their behavior toward humans.¹ Worldwide, many conservationists have echoed the sentiment that the film has hindered efforts to convince the public that sharks should be protected, rather than feared and hunted. Fortunately, this perception has begun to shift over the past decade with subsequent interest in protecting these animals.

Recent studies have focused on quantifying shark populations in various locations, and several have demonstrated population growth for the first time in decades.² Interestingly, the ocean surrounding Cape Cod, Massachusetts, has been identified as having one of the fastest-growing shark populations. Coincidentally, this portion of the state also represents a major referral area for our center.²⁻⁴ Due to a growing population of gray seals (*Halichoerus grypus*), it has been suggested that the Cape Cod area is home to a previously unrecognized breeding ground for some large species of sharks. These reports have frequently been sensationalized by local media, like other shark-related stories, as more sightings occur.⁴⁻⁶

As attacks occur infrequently, the impact of shark attacks does not typically merit the degree of apprehension they inspire. Nonetheless, when attacks occur, the victims present with significant tissue defects, requiring early intervention by reconstructive surgeons after initial resuscitation. This study aims to report the details of both fatal and nonfatal shark attacks in an effort to improve the treatment of shark-attack victims by plastic surgeons and highlight some of the reconstructive challenges inherent in the treatment of these patients.

Patients and methods

Using The Global Shark Accident File, maintained by the Shark Research Institute (Princeton, NJ, USA), investigation was conducted on the available data regarding shark attacks worldwide.⁷ This database represents a compilation of all known worldwide shark attacks dating back to the 1800s and contains approximately 6000 incidents. The database was queried for attacks occurring from 1900 through September 2014, with 5034 incidents being

documented. All known forensic data associated with each case were reviewed, including the attack date, the location of the attack, victim's gender, victim's age, lethality of attack, shark species, victim's injuries, and victim's activity during the attack.

A shark attack was defined as any encounter between a human and a shark which involved physical contact. The word "attack" is somewhat of a misnomer for these encounters between humans and sharks, but they have historically been recorded as such, and we use the word "attack" in this manuscript for the sake of consistency. Injuries were categorized by the number of separate body locations injured, and the location of bodily injuries (torso, head/neck, legs, or arms). Injuries were considered minor if they were solely abrasions, bruises, or small lacerations. Incidents were additionally categorized based on attack fatality. Statistical analysis was performed using the Fisher's exact test for dichotomous variables and *t*-test for continuous variables where appropriate. A *p*-value > 0.05 was considered statistically significant. Data analysis was performed using Microsoft Excel (Redmond, WA, USA) and GraphPad (La Jolla, CA, USA).

Results

Since the 1900s, a total of 5034 shark attacks on humans have been recorded. Of these incidents, 1205 (23.9%) were fatal and 3829 (76.1%) were nonfatal (Table 1). The victims were 80.4% male (4049) and 10.0% female (495); the gender was not reported for 9.8% of cases (490). The average age of all victims was 26.1 years (Table 1). Overall, since the 1900s, the number of shark attacks reported per decade has been on the rise (Figure 1). The relative number of fatal attacks has decreased. The percentage of fatal attacks has decreased steadily from 60% between the years of 1900 and 1909 to 13% between the years of 2000 and 2014.

A variety of anatomic injuries were described in each case ranging from no injuries to fatal injuries including decapitation. Table 1 summarizes the injuries sustained by all victims in aggregate; for 1177 incidents (23.4%), the injuries were unspecified. Minor injuries were sustained in 231 cases (4.6%) and, surprisingly, no injuries were reported in 716 cases (14.2%). A majority of victims sustained only one bite site, with 311 victims (6.8%) sustaining two bite sites, and 25 victims (0.5%) sustaining three bite sites. Legs were found to be the most common anatomic location of injury, which were involved in 2104 cases (41.8%). A total of 926 cases (18.4%) involved the arms and 373 (7.4%) involved torsos, while head and neck were the least frequently

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