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CASE REPORT

ANTHROPOLOGY

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Shark-Inflicted Trauma: A Case Study of Unidentified Remains Recovered from the Gulf of Mexico*

ABSTRACT: Here, we present a case of an unidentified male whose remains, except for the right arm, were recovered from the Gulf of Mexico 10 years prior to osteological analysis by forensic anthropologists. After the poorly preserved soft tissue was removed and the bones cleaned, forensic analysis revealed an unusual series of hard tissue trauma later attributed by a shark expert as shark scavenging and/or predation. Identified were five unique hard tissue trauma patterns that are bite mark artifacts produced by sharks: punctures without fractures, punctures with associated fractures, striations with bone shaving, overlapping striations, and incised bone gouges. The cooperation among experts provided a comprehensive death case analysis and a better understanding of shark-inflicted trauma on human skeletal remains.

KEYWORDS: forensic science, forensic anthropology, shark-inflicted trauma, shark attack, unidentified remains, human skeletal remains, Gulf of Mexico

In an effort to build a comprehensive database of unidentified human remains found in Louisiana, the Louisiana State University Forensic Anthropology and Computer Enhancement Services (FACES) Laboratory has reached out to law enforcement agencies and coroner's offices in the state's 64 parishes to ask for assistance in documenting all cold cases within their individual jurisdictions. One such case with unusual trauma is presented here.

On August 16, 1997, the Jefferson Parish Coroner's Office in south Louisiana was notified about the recovery of an unidentified male's remains in a commercial shrimp fisher's trawl net in the Gulf of Mexico. At the time of recovery, the shrimp boat was 30 miles offshore at longitude 28°29′9″N and latitude −90°26′3″W. The U.S. Coast Guard retrieved the body from the shrimp vessel, and an autopsy was conducted at the Jefferson Parish Forensic Center on August 18, 1997.

The original autopsy report noted that the body measured 5′11″ in length and weighed *c.* 83 pounds. The condition of the body was described as having "marked decompositional type changes present," with the head, right side of the chest and back, left upper arm, and the upper portions of both legs being devoid of flesh. The right arm was missing. "Irregular" gnaw-marks were noted on the remaining soft tissue. Partially digested food was found in the stomach. The brain was noted as being "generally liquid in nature." The heart, lungs, liver, kidneys, spleen, esophagus, thyroid, pancreas, and adrenals were present. No definite signs of fractures, hemorrhage, or other trauma, other than the gnaw-marks, were identified. A postmortem interval of <48 h from date of recovery was estimated based on the victim's weight:height ratio of 83 pounds:5′11″ and the presence of partially undigested food in his stomach. The weight:height ratio may suggest that in <48 h one-half of the victim's body weight had been removed by marine predation and scavenging. In the summary of the autopsy report, the cause of death was "considered to be probable asphyxia due to drowning."

On August 22, 2007, 10 years after initial recovery, the unidentified remains were released by the Jefferson Parish Forensic Center to FACES personnel and transported to the FACES Laboratory at Louisiana State University for osteological analysis and inclusion in the cold case database. Although no photographic documentation of the initial recovery of the remains from the Gulf was located, associated clothing that accompanied the remains included blue sweatpants, socks, and Tingley brand neoprene "Over-the-Sock Snugleg" steel-toed boots.

Trauma Analysis

Preliminary processing of the remains at the FACES Laboratory included X-raying the body and removal of the remaining soft tissue. The anthropological analysis of the bones revealed an unusual series of incised gouges, striations with bone shaving, overlapping striations, and punctures with or without associated fractures. The trauma was concentrated on the clavicles, right and left ribs, on all three of the left arm bones, the left femoral head, the right hip bone, and along the entire shaft of the right femur. The damaged skeletal elements were transported to the Florida Museum of Natural History at the University of Florida, Gainesville, FL, where the International Shark Attack File is curated to determine which marine scavenger(s) and/or predator(s) had caused the different types

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of trauma. The following trauma patterns on the bones were identified as common shark bite marks.

- Puncture without associated fractures (Fig. 1). This type of artifact typically occurs with a straight-on bite. A straight-on bite refers to an open and close bite where a shark's teeth penetrate the soft and hard tissue at a perpendicular angle. The form of the puncture artifact depends on whether the penetrating tooth was a wide-based, triangular-shaped upper tooth, or a sharp, spike-like lower tooth.
- Puncture with associated fractures (Fig. 2). When a straight-on perpendicular bite occurs in the thoracic region, multiple punctures with associated compression fractures can occur. In Fig. 2, the right fifth rib was punctured near the vertebral end and the right seventh rib was punctured near the sternal end and at midshaft. On rib 7, the puncture sites caused compression fractures.

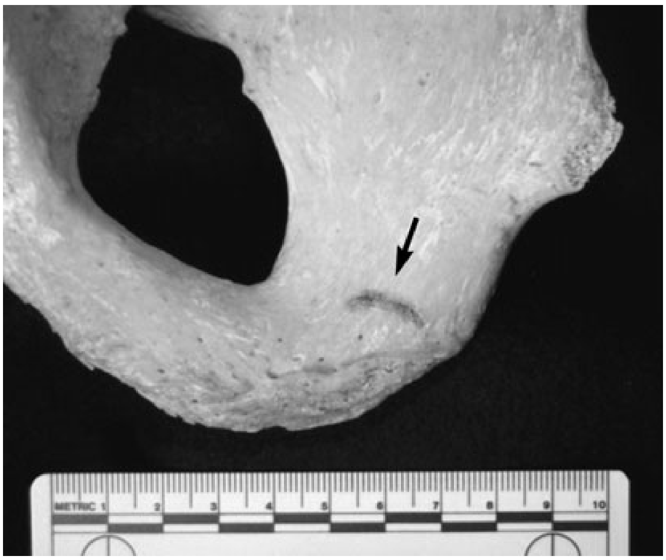

FIG. 1—*Right ischium, medial surface: arrow indicates location of a straight-on bite resulting in a puncture without associated fractures.*

FIG. 2—*Right ribs 5–9: the two arrows on right rib 7 (middle rib) indicate locations of compression punctures with associated fracturing. The arrow on right rib 5 (top rib) is another example of a puncture without associated fractures.*

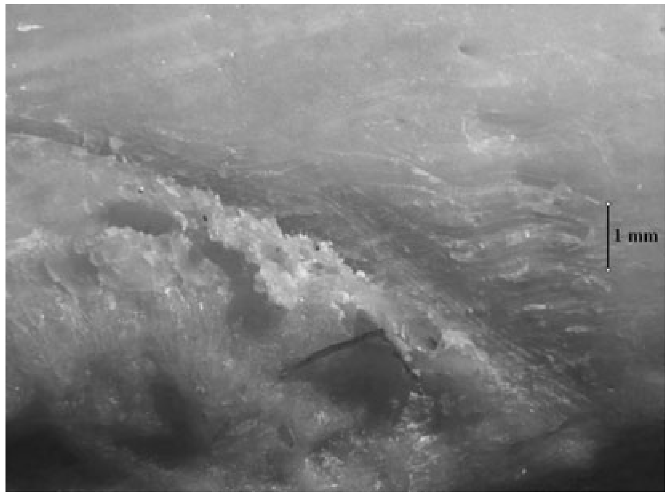

FIG. 3—*Close-up of right clavicle, superior surface: striations with bone shaving near the deltoideus muscle attachment site.*

- Striations with bone shaving (Fig. 3). This type of artifact is produced when a shark's tooth comes in fairly flat at a low angle that causes the tooth's serrated edges to be etched into the bone. Bone shaving occurs when the low-angled tooth digs into a bony protuberance and then slides off the bone.
- Overlapping striations (Fig. 4). During a bite, a shark's upper jaw is moving side-to-side in a saw-like motion. Overlapping striations result when the serrated edges of two adjoining, low-angled teeth come into contact with a bone.
- Incised bone gouges (Figs 5 and 6). This type of artifact occurs during the flesh stripping, saw-like motion of a shark's bite. During a successive bite series, the deepest end of bone gouge is where the initial force of the bite occurred. After initial contact, the tooth will follow the contour of the bone until it slides off. Multiple gouges traveling in the same direction are characteristic of several teeth striking the same bone during a single bite episode (Fig. 5). Multidirectional gouges on the same bone are common artifacts of several bite episodes (Fig. 6).

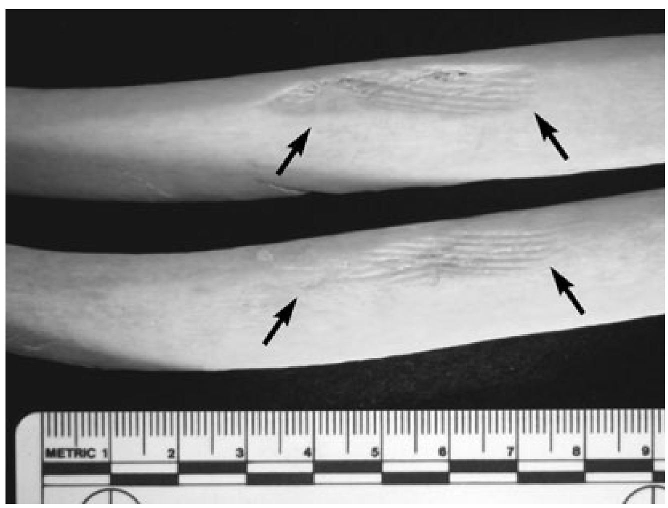

FIG. 4—*Right ribs 8 and 9: arrows indicate the locations of overlapping striations that result when two adjoining, low-angled teeth contact bone as the shark's upper jaw is moving side-to-side during a bite.*

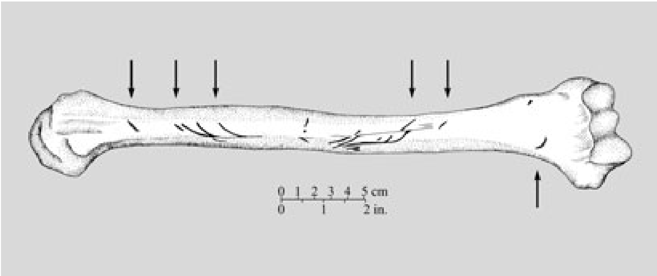

FIG. 5—*Left humerus, anterior surface: arrows indicate the locations of multiple incised bone gouges produced by several teeth during a single bite (exact representation of the trauma inflicted on the victim's left humerus).*

Discussion

The majority of reported shark attack cases are nonfatal. Typically, nonfatal cases involve the soft tissue and, in severe cases, the hard tissue as well. Since reported fatal shark attack cases are uncommon, forensic anthropologists rarely examine the hard tissue trauma directly associated with marine predation and scavenging to human remains; yet, with commercial and recreational activities on the rise in various salt-water regions, such cases may increase, especially in the warm Gulf waters of the South.

The Gulf of Mexico is a large geologic basin, bordered by a broad shallow intertidal region of estuaries and salt marshes. It hosts a wide variety of marine life including sharks, the system's apex predators. About two dozen nonplanktivorous species reach lengths of 2 meters or more, making them of potential concern to humans entering their domain.

In addition to feeding on a variety of organisms, including marine mammals, sharks occasionally attack live and dead humans (1,2). Unprovoked (no human provocation) shark attacks on live humans are relatively uncommon events and fatalities even rarer. During the most recent decade of documented cases (2000–2009), the average per-annum number of nonfatal and fatal attacks worldwide was 58 and five, respectively. Of these, yearly means of four nonfatalities and 0.2 fatalities occurred in the Gulf of Mexico (G. H. Burgess, personal communication, 2010).

Unprovoked shark attacks can be allocated into three broad categories (3–5). The most common type of attack is termed "hit-and-run," receiving its name because the attacker immediately exits following a single bite and is thought to largely represent cases of prey misidentification. This type of attack generally occurs in the surf zone where people are engaged in recreational activities like swimming and surfing. Soft tissue trauma (punctures and/or lacerations) occurs either from the shark biting and releasing the victim or from teeth-bared slashes as the shark swims by the victim. Less common are "bump-and-bite" attacks where the shark, after initially circling the victim, bumps the victim with its head or body prior to returning to bite. In the "bump-and-bite," sustained and repeated bites are the norm. The third type of interaction is termed "sneak attack." In sneak attacks, the initial bite occurs without prior contact or warning and often involves repeated and sustained bites. Bump-and-bite and sneak attacks are thought to occur when certain larger species of sharks are actively targeting the victim as an appropriate prey item. Injuries sustained from bump-and-bite and sneak attacks often receive high Shark-Induced Trauma scale scores based on major injuries (i.e., limb amputations, hemorrhagic shock, major tissue loss, and vascular damage) and may result in death (6,7).

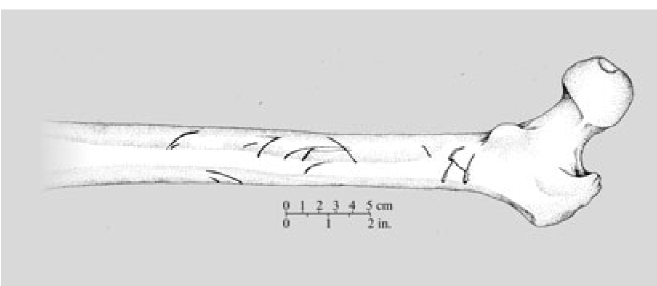

FIG. 6—*Right femur, posterior surface: multidirectional incised bone gouges from several bites (exact representation of the trauma inflicted on the victim's right femur).*

The location and angle of a shark's bite, either as a scavenger or predator, is affected by several variables. When a shark attacks, water is displaced and pushed out in front of the shark as a wave. This shark-induced wave, which likely varies in scope by the size and species of shark, may cause the victim's body to move in the direction of that wave. A second variable is the ocean's natural movements—currents, tides, and breaking surf—that affect the motion of both attacker and victim. Also important are the speed and direction of the shark and the victim's own movements. Just prior to a bite, most sharks "close" their eyes using protective nictitating membranes, temporarily losing sight and relying solely on near-field electromagnetic sensing during the actual bite. Finally, the accuracy of a shark's bite can be affected by the presence of other sharks and various predators and marine life.

A primary candidate for the trauma found on the case presented here is the bull shark (*Carcharhinus leucas*). It is a large species that reaches a maximum size of 11.5 feet and 500 pounds (8), inhabits both marine and fresh waters, and is a common inhabitant of the northern Gulf of Mexico where incoming Mississippi River waters result in reduced water salinities. An aggressive predator that routinely targets large prey such as sea turtles, marine mammals, and other sharks and is a well-documented attacker of humans (9), the bull shark's dentition is well equipped for such food items. The finely serrated, erect mandibular teeth (Fig. 7) are used to hold its prey while the broadly triangular, heavily serrated upper teeth (Fig. 8) facilitate cutting through flesh and bones.

For this victim, the hard tissue artifacts of shark-induced trauma included punctures, fractures, striations, incised gouges, and bone shaving. On the basis of geographical and bite locations, bite depth,

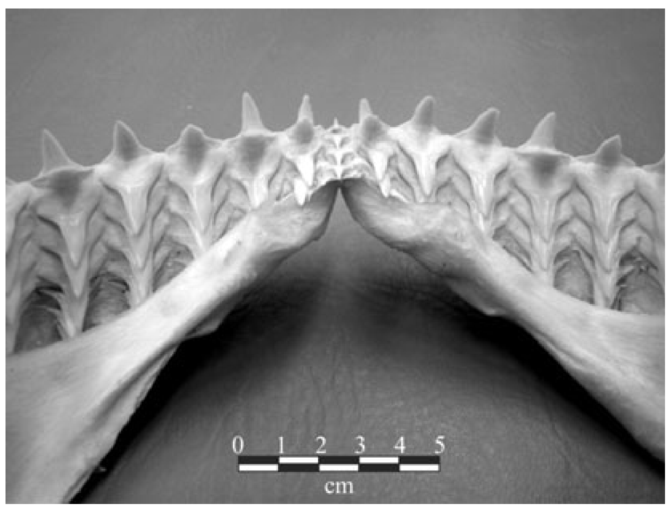

FIG. 7—*Bull shark's lower teeth.*

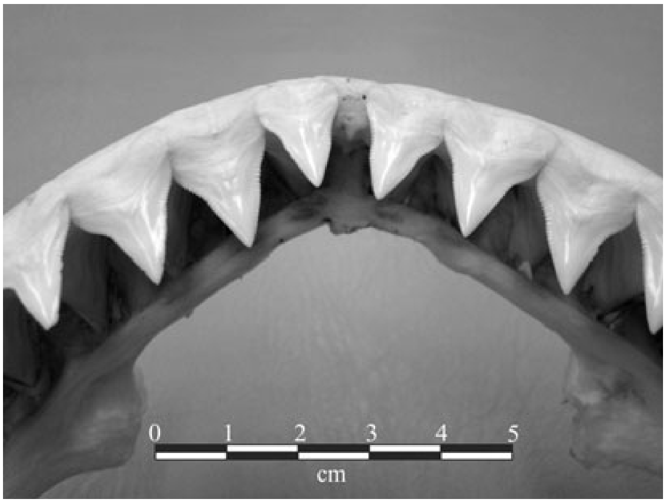

FIG. 8—*Bull shark's upper teeth.*

bite diameter, bite density, and tooth striations, the species of shark and size may be suggested (10). Accordingly, the bone trauma indicates that at least one 8–10 foot long bull shark (*C. leucas*), and one or more smaller (4–6 feet in length) requiem sharks of the genus *Carcharhinus* were involved.

In this case, differentiating between the shark-induced trauma as perimortem predation or postmortem scavenging was problematic. Due to the state of decomposition of the remains upon arrival at the FACES Laboratory some 10 years after death, soft tissue trauma assessment was inconclusive. Although some clothing was preserved, the lack of postmortem photographs at the recovery site or eye witness accounts resulted in the skeletal remains providing the only source of trauma analysis. Since the bone would have behaved in a plastic manner at the time of death and for some time following death, shark predation as a potential cause of death could not be distinguished definitively from postmortem scavenging.

Conclusion

Cooperation between forensic pathologists, forensic anthropologists, and a shark attack specialist assisted in clarifying the extensive soft and osseous tissue trauma inflicted on this victim. Although DNA information, along with the biological and dental profile, has been entered into various regional and national databases, the identity and circumstances surrounding his death remain unknown.

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