Case Report

Wilderness & Environmental Medicine
1-9

DOI: 10.1177/10806032251388579
www.wemjournal.org

Remarkable Survival by a Scuba Diver from an American Alligator Attack

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Abstract

The American alligator (*Alligator mississippiensis*) is a large (total length to 4.5 m [14.7 ft]) crocodilian common (estimated 3–4 million) in the southeastern United States. Attacks by alligators on humans are infrequent but increasing. We provide a case report of a scuba diver attacked by an adult alligator, describe the outcome, and discuss the injuries sustained by the diver. This attack occurred in the Cooper River of coastal South Carolina. The diver was seized by the right arm moments after surfacing and, in turn, hugged the alligator to avoid further trauma in the event of a death roll. The alligator carried the diver to the riverbed (estimated depth 15 m). The victim gouged the eyes and jaws of the alligator with a screwdriver, effecting his release, and then surfaced slowly to avoid decompression sickness. Subsequent medical examination indicated that the diver suffered a Monteggia fracture of the right ulna, characterized by an anterior dislocation of the radiocapitellar joint, and an oblique fracture of the proximal ulna. The Monteggia fracture was repaired by open reduction and internal fixation, with plate and screw fixation of the proximal ulna, postoperative alignment of the radiocapitellar joint, and staple fixation of the traumatic forearm. We estimated the total length of the alligator to be between 3 and 4 m and attribute the diver's survival to a number of factors—most notably the diver was equipped with scuba gear that allowed continued breathing when he was pulled beneath the water's surface by the alligator.

Keywords

Alligator mississippiensis, bite, defense, human-crocodilian interaction, Monteggia fracture, predator

Received: May 29, 2025; accepted: September 30, 2025

Introduction

The American alligator (*Alligator mississippiensis*) is a large (total length to 4.5 m [14.7 ft]) crocodilian occurring throughout the Gulf Coastal Plain of the southeastern United States, from Texas eastward to North Carolina and inland to Oklahoma and Arkansas (Figure 1).[1,2] Populations throughout this range were decimated by unregulated skin hunting from the 1800s to the 1960s, and as a result, the alligator was afforded federal protection under the Endangered Species Act in 1973.[2–4] Recovery was rapid following legal protection, with the alligator being removed from the Endangered Species List in 1987. The wild population is now estimated to number 3 to 4 million nonhatchling alligators, with the largest numbers reported from Louisiana and Florida.[2] Although not generally considered a threat to humans, attacks by alligators, albeit infrequent, are well documented and appear to be increasing concurrently with expanding human and alligator populations.[3,5–9] Despite the growing number of alligator attacks on humans, only a handful of case reports describing the circumstances and pathology of such attacks are available in the scientific literature.[3,9,10] We provide a case report of a scuba diver attacked by a large adult alligator, describe the outcome of the attack, and discuss the injuries sustained by the diver.

(Correction November 2025): In the original publication, the year of the alligator attack under 'Case Report' was incorrectly stated as 2014; this has been corrected to 2024.

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Figure 1. An adult (total length 3.6 m [12 ft]) male American alligator (*Alligator mississippiensis*; "Cudjoe") basking on the bank of a wetland in coastal South Carolina. Photo by Philip Wilkinson.

Case Report

On April 15, 2024, one of us (WSG, a 40-y-old male) was scuba diving for fossils on the Cooper River (33.026724, −79.914764) in Berkeley County, South Carolina. The dive originated at 1300 h from a 5-m motorboat ~12 to 15 m from the northern shore on an incoming tide. Another person was in the boat during the dive, which was then moved ~45 m upriver from the diver and anchored among aquatic vegetation along the shoreline. WSG descended to the bottom of the river, where the depth varies between 13 and 15 m (as determined by the depth gauge attached to the diver's air gauge). At ~1400 h, WSG's air supply had reached 51.7 bar (750 psi), at which time he ended the dive and began ascending. Cognizant that surfacing near the shoreline in this stretch of the Cooper River may be potentially dangerous because of the presence of alligators, WSG moved an additional 12 m away from the shore and then made his final ascent to end the dive.

WSG reached the water's surface ~27 to 36 m from the northwestern bank of the river with 41.3 bar (600 psi) remaining in his air tank. On surfacing, he immediately saw a large alligator about halfway between himself and the shore (13–18 m) that instantly and rapidly began swimming toward him. From WSG's vantage point, the anterior half of the alligator (head and torso), propelled by the tail, appeared to be slightly elevated above the water's surface as the animal rushed toward him. Within ~3 to 4 s, the alligator reached WSG and, just before making contact, opened its jaws and turned its head ~90 degrees to the right (diver's left). WSG raised his right arm to shield himself from the attack and with a screwdriver (attached to his right wrist by a lanyard, used to hold the diver in place on the river bottom in strong currents) jabbed toward the underside of the alligator's lower jaw to push the head away. The alligator quickly snapped back to its left and bit down on and grasped WSG's arm just behind the large caniform teeth on its upper jaw (almost halfway into the mouth) (Figure 2A). WSG's arm was bent at a slight angle such that the points of contact with the alligator's teeth were ~7.5 cm proximal to the wrist (right side of jaw) and ~2.5 cm proximal to the elbow (left side of jaw) (Figure 3). WSG immediately attempted to hug (ie, wrap his free arm and legs around) the alligator's head and neck to avoid further trauma to the bitten arm in the event the alligator began spinning its body, a maneuver commonly performed by crocodilians to subdue and dismember prey (ie, body-rolling inertial feeding, rotational feeding, or death roll[11,12]). The alligator immediately pulled WSG underwater, ~1 m below the surface. However, because WSG still had his regulator in his mouth and a small amount of air left in his tank, he was able to continue breathing. With his left hand, WSG was quickly able to locate the screwdriver dangling from his right wrist, which was protruding from the right side of the alligator's jaws, and attempted to drive the shaft of the tool into the alligator's right eye.

Figure 2. A generic American alligator (*Alligator mississippiensis*) skull showing the changing positions of the scuba diver's right arm (denoted by black bar) during the attack. A, On the initial bite, the arm was grasped proximal to the wrist (right side of jaw) and slightly proximal to the elbow (left side of jaw) behind the alligator's large caniform teeth, approximately halfway into the mouth. B, After being gouged in the eye with a screwdriver, the alligator violently shook the victim, at which time the victim's wrist and forearm shifted to the posterior corner of the jaw while the elbow remained in place. C, After being gouged in the teeth and gums with the screwdriver, the alligator shook the victim a second time, at which time the victim's entire arm shifted to the anterior portion of the mouth. Photos by Kristen Grace, Florida Museum of Natural History.
R, right; L, left.

Figure 3. Photograph of the victim's right arm 11 d after the attack. The primary points of contact (white arrows) with the alligator's teeth were ~7.5 cm proximal to the wrist (top arrow, right side of jaw) and ~2.5 cm proximal to the elbow (bottom arrow, left side of jaw). Photo by Will Georgitis.

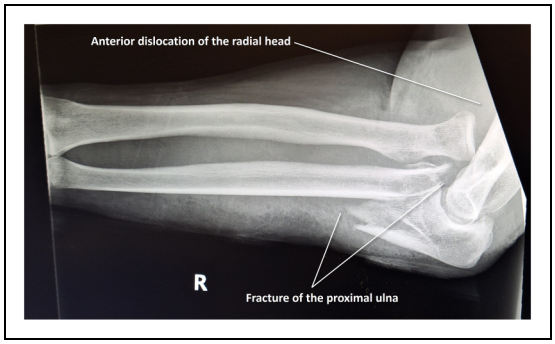

Figure 4. Radiograph of the victim's right arm showing a Monteggia fracture, characterized by an anterior dislocation of the radiocapitellar joint, and an oblique fracture of the proximal ulna with anterior displacement of 2.4 cm (~4-cm overlap). Photo by Will Georgitis.

The tough skin of the alligator's eyelids provided considerable resistance, but WSG apparently was successful inflicting pain or discomfort to the alligator because the animal responded by violently shaking its head from side to side, easily freeing itself from the screwdriver and the diver's grasp (WSG recalled being "shaken like a rag doll" and feeling powerless by this display of strength) while still firmly biting onto the arm. During this struggle, the position of the diver's wrist and forearm shifted to the back right of the alligator's jaws while the position of the arm above the elbow remained the same (Figure 2B). WSG quickly recovered and again was able to hug the alligator around the head and neck. Before WSG could retrieve the screwdriver and gouge the eye a second time, the alligator dove (nose down and with WSG positioned in front of and beneath its snout) and pulled him to the bottom of the river, a depth of ~15 m (~50 ft; see above). During the quick descent, WSG recalled noticing the increasing water pressure in his ears, fading sunlight, and water rushing over his shoulders. WSG also fully inflated his buoyancy control device at this time because he thought that any increased resistance might make it more difficult for the alligator to pull/hold him underwater, and he assumed that if he did not survive, the buoyancy might carry his body to the surface. Once on the bottom of the river, the alligator rested its weight onto WSG's chest, pinning his back to the marl substrate as WSG maintained his hug around the alligator's head and neck. WSG could detect no visible light at this depth. The duration of the diver-alligator interaction to this point was ~1 to 1.5 min.

WSG then attempted to locate the screwdriver attached to his right wrist. He discovered he no longer had feeling in his right hand and thus had not realized it had shifted to the rear of the jaws. WSG was able to run his left hand down the right side of the alligator's jaws to locate his right hand at the posterior corner of the mouth. WSG located the screwdriver, aligned its tip between the alligator's teeth, and jammed it into the gums and bone on the right side of the mouth. The alligator "clacked" its jaws (two to three rapid bites) and thrashed WSG again. During this second shake by the alligator, WSG's entire arm moved anteriorly, closer to the front of the mouth and just behind the large caniform teeth on the bottom jaw (Figure 2C) but still perpendicular to the alligator's body. At this point, WSG's air supply expired completely. With no air remaining, WSG pulled his knees to his chest, placed both of his feet (fins) on the alligator's neck and lower jaw for leverage, grasped his right wrist with his left hand, and with all his strength attempted to pull his trapped arm from the alligator's mouth. The arm suddenly ripped free of the alligator's jaws, causing tissue damage at the two points of tooth contact (Figure 3). WSG, mindful of the potential for decompression sickness with a quick ascent, swam slowly to the water's surface at an angle (rather than directly above). While ascending, the air in his lungs expanded, and he exhaled a stream of bubbles as he rose for ~30 to 60 s. On reaching the surface (~1403 h), the person in the boat quickly drove to WGS's position and assisted him out of the water. No first aid was attempted because the tightness of WSG's semi-drysuit appeared to provide ample pressure on the wounds to limit bleeding. The boat driver drove the boat back to the landing and

transported WSG by car to the nearest hospital, ~16 km (10 mi) away. The alligator was not seen again.

On medical examination, radiographs (3 views of the right forearm and 3 views of the right elbow) showed that WSG suffered a Monteggia fracture of the right ulna, characterized by an anterior dislocation of the radiocapitellar joint, and an oblique fracture of the proximal ulna with anterior displacement of 2.4 cm (~4-cm overlap of fracture fragments) (Figure 4). The distal radius and ulna, carpal bones, radiocarpal joint, and phalanges were intact. Postcontrast computed tomography images were obtained from the right shoulder to the right hand after the timed intravenous administration of 100 mL ISOVUE 370 contrast agent (Bracco Group, Milan, Italy). Three-dimensional maximal intensity projection reformatted images as well as sagittal and coronal reformatted postcontrast images were obtained. The right subclavian, axillary, and proximal brachial arteries were patent, but the minute distal brachial artery exhibited several areas of intimal irregularity. The radial artery was patent throughout its course. There was an abrupt cutoff of the proximal ulnar and interosseous arteries with reconstitution midforearm. The radial and ulnar arteries were patent at the wrist. No evidence of active extravasation was noted in any artery, nor were any venous injuries observed. Soft tissue gas and edema occurred posteromedially within the distal upper arm and proximal forearm. No focal fluid collection was noted. Monteggia fractures are typically associated with high-energy impact injuries, and the fracture in this case reflects the extreme bite force of a large adult American alligator.[13–16] The Monteggia fracture was repaired by open reduction and internal fixation, with plate and screw fixation of the proximal ulna, postoperative alignment of the radiocapitellar joint, and staple fixation of the traumatic forearm (Figure 5).

Figure 5. Radiograph (39 d postoperatively) of the victim's arm after open reduction and internal fixation of the Monteggia fracture. The image shows plate and screw fixation of the proximal ulna with acceptable postoperative alignment of the radiocapitellar joint. Staple fixation of the traumatic forearm wounds is also noted. Photo by Will Georgitis.

On discharge from the hospital, WSG was prescribed multiple antibiotics, anticoagulants, and pain medications. The available medical records (provided by WSG) did not include the duration of the medication regimens. In addition, in some cases, WSG exhibited an adverse reaction to a medication, which was immediately discontinued and replaced with a substitute (ie, the full suite of medications listed was not taken all concurrently); however, WSG was unable to recall which medications were replaced or their replacements. Antibiotics prescribed included amoxicillin/clavulanic acid (875 mg/125 mg, one tablet orally bid), metronidazole (500 mg, one tablet orally tid), cephalexin (500 mg, one capsule orally q12h), and cefdinir (300 mg, one tablet orally bid). Pain medications prescribed included acetaminophen/hydrocodone bitartrate (325 mg/5 mg, one tablet orally q12h as needed), acetaminophen/oxycodone (325 mg/10 mg, one tablet orally q6h as needed), tramadol hydrochloride (50 mg, one tablet orally q12h as needed), gabapentin (400 mg, one capsule orally qd), and methocarbamol (750 mg, one tablet orally q4h as needed). Anticoagulants prescribed included apixaban (5 mg, one tablet orally bid), rivaroxaban (15 mg, one tablet orally qd), warfarin sodium (4 mg, one tablet orally qd), clopidogrel (75 mg, one tablet orally qd), and aspirin (81 mg, one tablet orally qd).

To estimate the size of the alligator involved in the attack, we used morphometric data from 65 juvenile and adult American alligators (mean total length 2.5±0.1 [SE] m [8.3 ft], range 1.4–3.4 m [4.8–11.2 ft]) captured in coastal South Carolina during 2011–15 (P.M. Wilkinson and T.R. Rainwater. May 15, 2025) to develop a predictive model for determining body size from measurements of snout width.[17,18] Specifically, we fit untransformed morphometric data with least-squares linear regressions to determine the predictive relationship between 1) snout width (independent variable; basal snout width measured across the anterior orbital borders) and total length (TL; dependent variable, measured dorsally, from the anterior tip of the snout to the posterior tip of the tail) and 2) snout width and snout-vent length (SVL; dependent variable, measured dorsally, from the tip of the snout to the posterior margin of the third caudal whorl

of scales[17–19]). Strong positive allometric relationships ($r^2 \geq 0.80$) were found between measurements of body length (TL and SVL) and snout width (SW) (Figure 6), described by the equations TL=9.96(SW)+85.07 and SVL=5.77(SW)+35.65, respectively. We then used the distance between the 2 outermost (primary) bite wounds on WSG's arm (19.05 cm [7.5 in]; Figure 7) as a proxy for the attacking alligator's snout width (SW) in these equations to yield alligator length estimates of 2.74 m (8.9 ft) TL and 1.45 m (4.7 ft) SVL. However, additional analysis suggested that these model estimates may be low (possibly due to few animals >3.4 m [11 ft] TL in the dataset used to generate regression equations). Five weeks following the attack, we carefully placed WSG's injured arm into the jaws of the skull from a 3.8-m (12.6-ft) alligator, and the outermost (primary) bite wounds appeared to line up closely with the mandible, maxilla, and associated teeth (Figure 8). Acknowledging possible measurement error and slight differences in the position and angle of the arm while in the mouth of the skull versus that of the attacking animal, based on WSG's description of the animal, our morphometric models, and the skull comparison, we speculate that the alligator involved in the attack had a total length of between 3 and 4 m (10 and 13 ft). This also would suggest that the alligator was an adult male, because female alligators rarely exceed 3 m (10 ft) in length, particularly in South Carolina.[20]

WSG had no health insurance coverage at the time of the attack and, as a result, incurred major medical expenses from his surgery and associated treatments. He obtained advice on physical therapy from a family friend who provided detailed regimens to follow. Overall, he performed ~20 different movements/exercises for 1 to 1.5 h twice daily for ~7 mo. As of this writing (1 y and 125 d following the attack), WSG has regained ~90% mobility and 80% strength in the injured arm, with some occasional aching and numbness. Estimates of mobility and strength were made by the victim over time through comparisons of his injured arm with his uninjured arm.

Discussion

Few, if any, reports exist of humans being pulled to the bottom of a water body by a large crocodilian and surviving. Indeed, the likelihood of surviving such an attack is extremely low.[21] We contend that a combination of several factors related to both the alligator's and victim's behavior, as well as access to diving gear, contributed to the victim's survival in this case. First, on rapidly approaching the victim at the water's surface, the alligator grasped the victim's arm in its jaws and held him there without spinning/twisting its body (death roll). Had the animal immediately rolled or thrashed the victim, it is likely that WSG would have become severely disoriented, injured, incapacitated, or a combination of these, significantly reducing his ability to resist further attack. Second, WSG's knowledge that crocodilians often employ the death roll to subdue or disorient prey and his presence of mind to hug the alligator's head and body to prevent it from rolling, or at least allow him to spin with the animal to prevent greater trauma to his arm and shoulder in the event rolling occurred, may have prevented the alligator from attempting this maneuver. It also inadvertently well positioned WSG to later reach the alligator's eye with the screwdriver. Third, the fact that WSG was equipped with scuba gear is the single most critical factor contributing to his survival. Having the regulator in his mouth and air left in the tank when the attack was initiated allowed WSG to continue breathing after the alligator pulled him underwater. Although most mammalian prey struggle and drown within seconds of being submerged, the victim in this case was able to maintain respiration and continue attempts to free himself from the alligator.[10,22,23] Fourth, the screwdriver tethered to the wrist of WSG's bitten arm provided a uniquely suitable tool for attempting to escape the alligator's grasp. Many human survivors of crocodilian attacks have done so by gouging or striking sensitive areas on the animal's head (usually the eyes but also the ears, gums, and snout) with their fingers or other objects, presumably inflicting pain on the animal and forcing it to release its grip.[23,24] In this case, the fact that the screwdriver was tethered to the wrist of the bitten arm and was still accessible (ie, dangling below the alligator's jaws, not torn free of the lanyard or lodged inside the animal's mouth) allowed the victim to grasp it with his free hand and repeatedly plunge it into the alligator's eye. And again, the victim's knowledge that gouging sensitive areas on an alligator's head is an effective strategy for escaping an attack (bite) and the presence of mind under great stress to do so greatly contributed to his survival. This is especially true when, on the bottom of the river, the victim gouged the alligator's gums with the screwdriver, causing the animal to shake its head and in doing so shift WSG's bitten arm to the front of the mouth. Fifth, the victim's presence of mind to inflate his buoyancy control device while being pulled to the river bottom may have created extra resistance that induced some additional fatigue in the alligator. Sixth, when his air supply became exhausted while pinned on the river bottom, WSG's desperation and fortitude to make a final attempt to pull his arm from the jaws of the alligator were obviously vital to his survival because he successfully freed his arm. Seventh, WSG's presence of mind and ability to swim to the surface slowly, to prevent decompression sickness, were essential to his survival and an amazing feat given the circumstances (eg, oxygen deprivation, trauma, and exhaustion). Eighth and last, WSG swam to the surface at an angle under the assumption that the alligator most likely would ascend directly above and that this would create space between

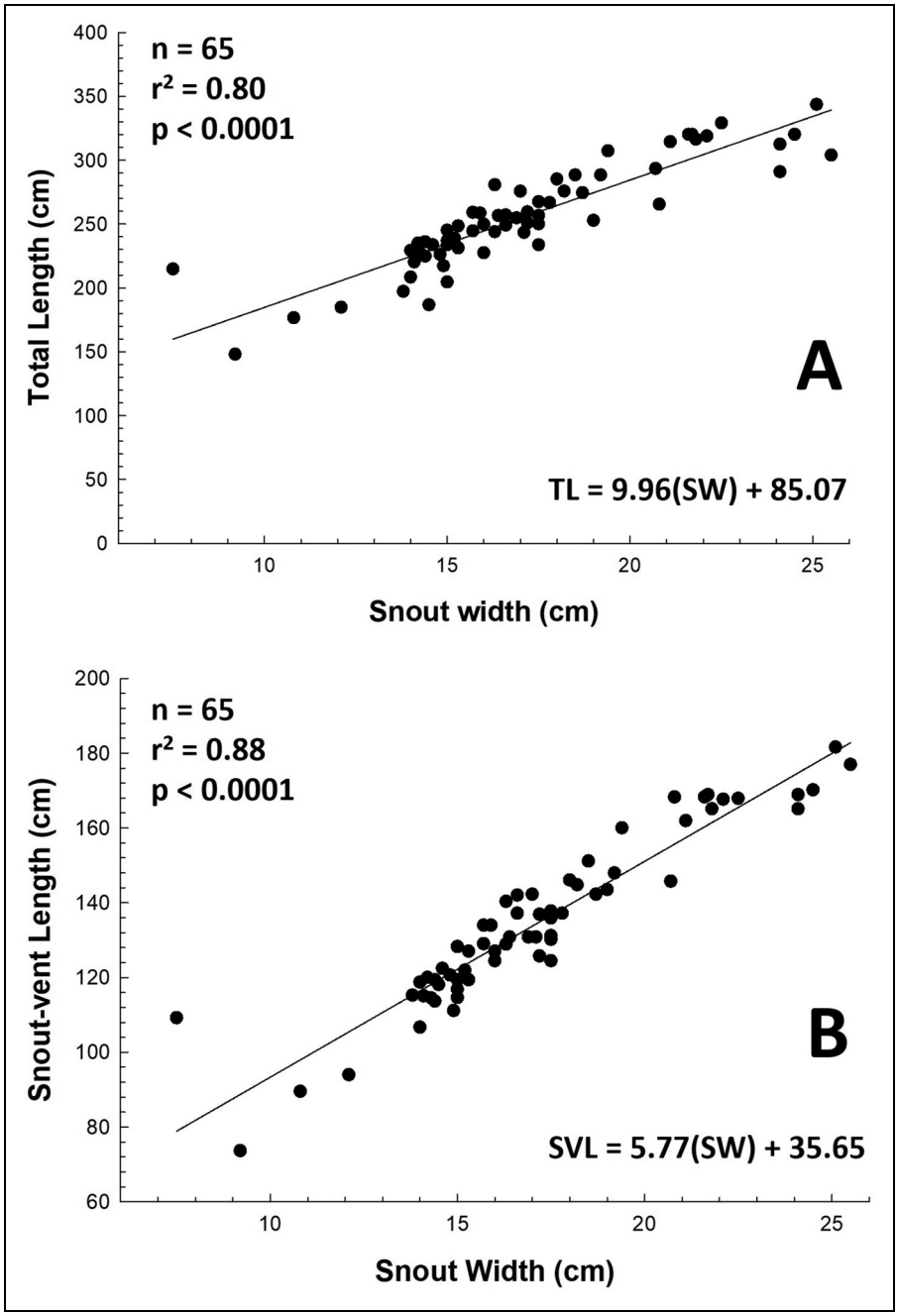

Figure 6. Relationship between (A) total length (TL) and snout width (SW) and (B) snout-vent length (SVL) and snout width of 65 juvenile and adult American alligators (*Alligator mississippiensis*) in South Carolina (2011–15). TL and SVL exhibit strong positive allometric relationships with snout width (proxy for the distance between the two outermost [primary] bite wounds on the victim's arm), providing predictive models (equations) for estimation of the attacking alligator's body size.

the two at the water's surface, possibly preventing or delaying a second attack.[5,25] Because the alligator was not seen again, it is unknown if this strategy was warranted or contributed to WSG's survival.

The attack described in this case report is the fourth documented case of a scuba diver being attacked by an American alligator in South Carolina.[26] Interestingly, all 4 attacks occurred in the same area of the Cooper River, a popular location for fossil diving, and all were nonfatal. The first attack occurred in September 1987, when a 31-y-old female diver was bitten by an ~1.2-m (3.9-ft) animal while submerged at 18.2 m (59.7 ft).[26] The second attack occurred on September 1, 2001, when a 30- to 40-y-old male diver surfaced in the middle of the river and an ~2.1-m (6.8-ft) alligator charged him with its mouth open.[26] The diver pushed the animal away with

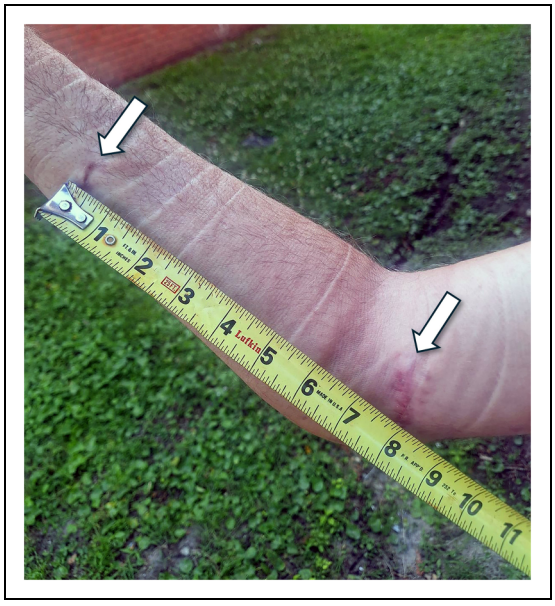

Figure 7. Photograph showing the approximate distance between the two outermost (primary) bite wounds on the victim's arm (19.5 cm [7.5 in]) 5 wk after the attack. Photo by Barry Segura.

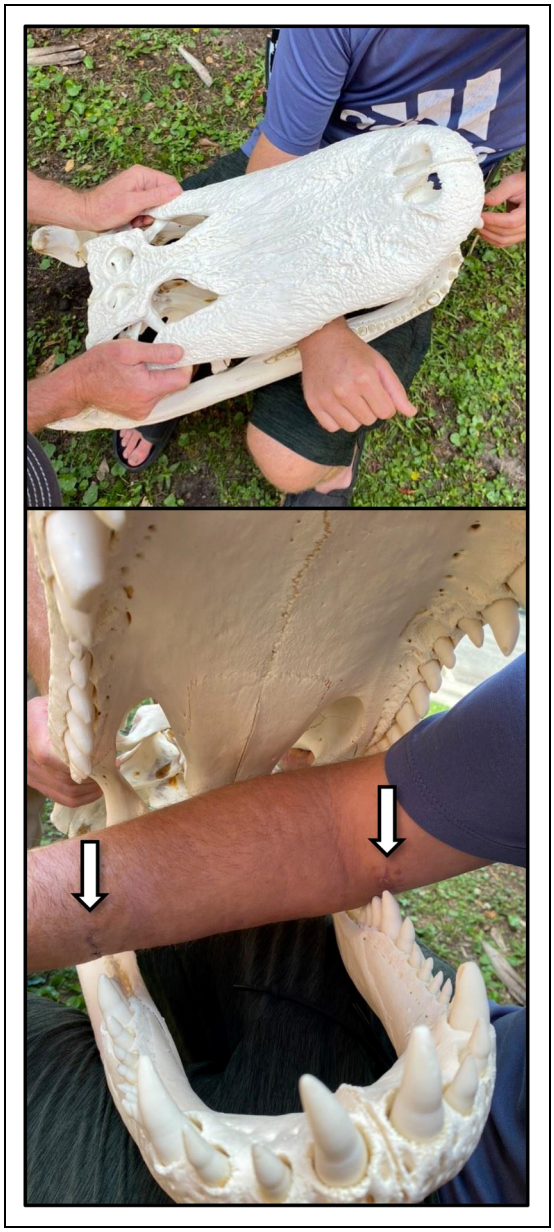

Figure 8. Photographs showing the victim's injured arm (5 wk after the attack) in the jaws of a skull from of a 3.8-m (12.6-ft) American Alligator (*Alligator mississippiensis*). The outermost (primary) bite wounds (white arrows) align closely with the mandible, maxilla, and associated teeth of the skull. Photo by Barry Segura.

his dive light, the handle of which was bitten off by the alligator. The diver required 6 stitches on his hand, which was grazed by one of the alligator's teeth. The dive outfitter indicated that over time he had observed commercial crabbers repeatedly feeding alligators in the area (feeding may habituate wild alligators to humans and is illegal in all US states within the animal's range except Louisiana[3,7,8]). The third attack occurred on March 14, 2016, when a 64-y-old male diver was bitten on the head without warning by an ~3.3-m (10.8-ft) alligator, presumably while both were submerged.[26] The bite left 5 punctures in the top of the victim's head and 2 punctures in the lower jaw, which collectively required 3 stitches and 5 staples. The fourth attack is the one described in this case report. Although the victim (WSG) was aware that alligators were common in the Cooper River, he had dived there many times and had never encountered one. In the days following the attack, several other fossil hunters contacted the victim and reported that they had dived in the area just prior to the attack and had not observed any alligators. However, over the ensuing weeks and months, several other divers and fishermen that frequent the attack location informed WSG that they had encountered a large alligator there on multiple occasions and described it as "very aggressive," often charging boats and assuming an inflated body posture (presumed territorial display[27]). One fisherman who contacted WSG shortly after the attack informed him that some days before the event he had observed multiple wild pigs (*Sus scrofa*) swimming across the Cooper River at the attack location. It is possible that the attacking alligator was in the area exploiting this food resource and was alert to large mammals swimming in this stretch of the river when the victim made his dive.[28] Additionally, boaters and other river visitors may have illegally fed alligators in the area, reducing their wariness of people and increasing their association of humans with food.[7–9] However, Woodward et al[7] found that while some alligator attacks (31.2%) on humans in Florida reportedly involve animals fed by people, most (68.8%) do not. Finally, the attack

occurred during the spring, when warming ambient temperatures increase alligator feeding rates and coincide with the breeding season, when male alligators more aggressively defend territory.[7,27,29,30] Whether these alligator attacks were predatory or defensive, the popularity of this stretch of the Cooper River for fossil hunting has resulted in an increased number of scuba divers in the area sharing the water with alligators for extended periods, creating a potential hotspot for negative human-alligator interactions.[31–33]

Conclusion

The likelihood of a human surviving an attack by a large crocodilian after being bitten and held underwater for almost 3 min is extremely low.[21,24] Indeed, only in rare circumstances such as the one described in this case report, in which a victim can continue breathing while underwater, is a human likely to even have a chance of survival. Previous authors have made recommendations on ways to minimize or avoid alligator attacks.[3,7,9] Foremost is that persons swimming (or walking) in areas where large alligators (or other crocodilians) are known or likely to occur should always maintain high levels of situational awareness.[7,8] However, few reports have provided recommendations on how to respond to an attack. Details shared by the survivor of this alligator attack provide some insight into alligator behavior during an attack and defense measures that may be useful to victims of future attacks. This incident suggests that if attacked and grasped by an alligator, a person should fight back, if possible, with powerful blows to the animal's eyes and snout. Forcefully plunging fingers or other objects into the eyes and mouth (and presumably ears) appears to be an effective means of inflicting pain or discomfort on attacking crocodilians, possibly resulting in the animal releasing its grip. However, inflicting pain on the attacking animal also may cause it to react violently, thrashing the victim and/or quickly moving into deeper water, as occurred in the attack described in this report. If attacked in shallow water, victims should do whatever possible to avoid being pulled underwater or into deeper water. If the alligator engages in a death roll, hugging the animal's body or being able to roll with the animal may help prevent further trauma (eg, twisting) to the body part being grasped. If the victim escapes, it is important to exit the water as rapidly as possible and quickly seek medical attention to evaluate the wounds and treat for microbial infection.[7,25]

On May 1, 2025, WSG made his first dive since the alligator attack (1 y and 15 d later). The dive occurred in marine habitat off the west coast of Florida. As of this writing (August 2025), WSG has not returned to the attack location. He had dived that area of the Cooper River more than 60 times previously but had not visited in more than 3 years prior to the attack, after finding more productive areas for fossil hunting elsewhere.

Acknowledgments

We thank John Sanders, (MD) (orthopedic surgeon; not associated with the case reported in this paper) for assistance with the medical description of the injuries and treatment reported in this case report. This paper represents technical contribution number 7434 of the Clemson University Experimental Station.

Author Contribution(s)

Thomas R. Rainwater: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Validation; Writing – original draft; Writing – review & editing.

William S. Georgitis: Conceptualization; Investigation; Methodology; Resources; Supervision; Visualization; Writing – review & editing.

Brandon M. Sideleau: Conceptualization; Data curation; Investigation; Methodology; Software; Supervision; Visualization; Writing – review & editing.

Steven G. Platt: Conceptualization; Formal analysis; Investigation; Methodology; Supervision; Visualization; Writing – original draft; Writing – review & editing.

Financial/Material Support

TRR was supported by the Yawkey Foundation and Clemson University. SGP was supported by the Wildlife Conservation Society.

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