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Case report of death by diving with subsequent face trauma and brain trauma

Abstract

The scope of this article is to describe death from brain injury, resulting from a deceleration mechanism, which occurred when diving and leading to facial trauma. Research was conducted in the literature and there is no report of this type of trauma triggering encephalic lesion (brain injury). In the literature search, only cervical lesions caused by diving were found.

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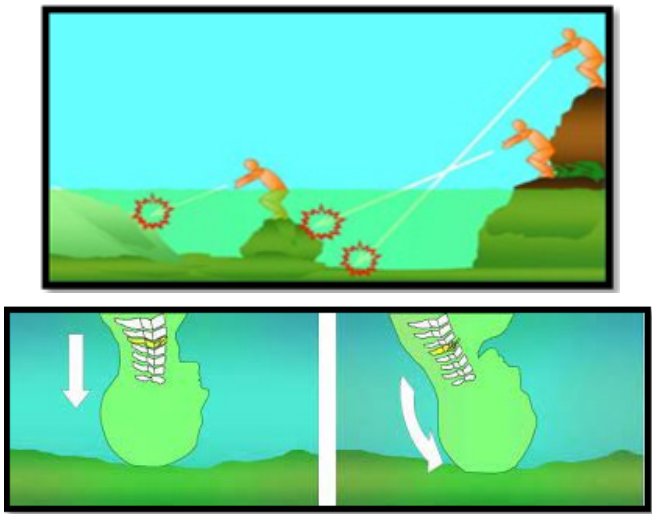
Introduction

The risk of accidents when diving in the sea, swimming pools, rivers or waterfalls is associated with the way people enter the water. Nine out of ten people who suffered a diving accident became quadriplegic and the majority are male. When diving, every individual expects to enter the water and surface further ahead. For the dive to be successful, there must be sufficient depth of water in the location.[1]

When there is insufficient depth, either because of a narrow shaft of water, or because of the existence of some type of obstacle, such as a rock formation, as a rule, the skull collides with the outcrop. The resulting force causes fracture and dislocation-fracture of the spinal column, as shown in the sketches[2] to the right.



Diving accidents are the fourth leading cause of spinal cord injury in the USA, behind firearm accidents, car accidents and falls.[3] It is estimated that 65,000 accidents across the US annually are related to swimming pool activities[4] and typically occur during the summertime.[5] Diving accidents are one of the main causes of spinal cord injury in several countries,[3] representing 19.8% of all cervical spinal cord injuries in Poland (1); 23.5% in Russia; 4% in Germany; 8.5% in the US; 7% in Romania; 11.9% in Canada and 14% in Australia.[6] In a bibliographic survey carried out in Medline and Lilacs, no data were found regarding spinal cord injury due to diving in Brazil.

According to Blanksby et al, 89% of injuries occur in shallow water, where the depth is less than 1.52m;[7] DeVivo claims that 57% of injuries occur when the victim plunges into less than 4 feet (1-2 meters) of water.[8] For Green, 76% of spinal cord injuries that occurred in swimming pools were at depths of less than 5 feet. In this study 63% of the victims involved had little or no familiarity with the pool. In most cases of patients with spinal cord injury caused by diving, the individuals were under the influence of alcohol.[9] Spinal cord injury caused by diving is more frequent in young and healthy individuals, in which most of them develop quadriplegia and disability for the rest of their lives.[6] The mean age is 21 years, with a predominance of males.[10] There is an increased frequency among young people, especially adolescents involved in recreational activities, "playing" in the water and especially during the summertime.[11] Most injuries occur from diving headfirst into unfamiliar, dark waters, particularly lakes, shallow, murky waters, and unfamiliar pools. The lesion level usually affected is between C4-C6, normally with total lesions.[12] The involvement of the C5 vertebra is the most frequent, with a higher incidence of complete lesions,[13] namely loss of motor and sensory function up to the S4-S5 sacral segments.

Cervical lesion mechanism

The mechanism of cervical injury usually operates by hyperflexion and compression. Less frequently, it may occur by hyperextension with lateral flexion or rotation mechanism; these phenomena can also occur in conjunction. In most circumstances, divers hit their head on the bottom of the pool, river or sea.

There are 4 types of vertebral injuries:[6]

I. **Teardrop fracture:** as described by Schneider and Kahn in 1956. It is usually used to describe a flexion-compression injury of the cervical spinal cord, characterized by compression of the spinal column and dislocation of same.

II. **Burst fracture (explosion fracture):** characterized by fracture of the spinal column with impaction of the bone into the vertebral canal, which is caused by an axial load with or without a degree of flexion.

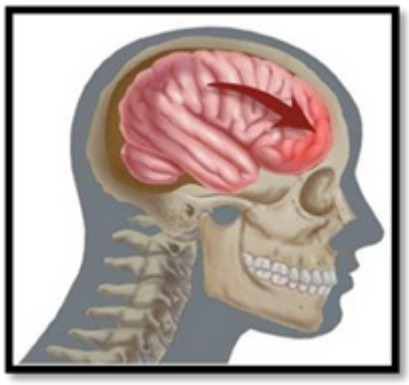
III. **Displacement without fracture:** suggests a flexion force lesion with distortion, resulting in posterior and complex disc failure.

IV. **Other types of fracture:** lateral-flexion injury and compression-extension injury combined with different degrees of rotation.

Mechanism of brain injuries by acceleration and deceleration

In blunt trauma, characterized when there is no contact with the intracranial contents, primary lesions may result from brain motion associated with the kinetic energy of the accident. In lesions resulting from acceleration and deceleration forces, it is not necessary to impact the skull against external structures. As the brain and cranium have different densities, when subjected to the same inertial forces, they respond unequally. This mismatch of movements can promote the rupture of cerebral veins that flow into the dural sinuses, as well as impact and laceration of the parenchyma against the rigid structures of the skull. In addition to this mechanism, as the central region of the brain is relatively fixed due to the presence of the brainstem, the peripheral regions of the brain and cerebellum tend to present greater range of motion. This difference in the amplitude of movement between the central and peripheral regions of the brain generates the stretching of axons and cerebral blood vessels, which can result in anything from a temporary dysfunction to rupture of these structures.[14,15]

In the picture to the right, we represent the mechanism of trauma by deceleration, with the skull going against a fixed structure.



NDFS, 17 years old, was admitted to our service with a cause of death described as drowning, with a history of having dived, in the coastal area of the Rio de Janeiro coastline, two days before being found, floating close to the place where he made the dive. Relatives report that soon after the dive, he emerged, waved as if asking for help, submerging soon after, not to be seen again.

Report of necropsy findings relevant to this report:

The body already showed typical signs of putrefaction, such as peripheral vascular trauma, and detachment of the epidermis in various parts of the body. The body was submitted to radiological examination in order to rule out a possible cervical lesion, since it is the most common form of injury found in cases of death by diving, as well as skull fracture.

In the photograph to the right, we present the radiological examination of the spinal column, obtained during the necropsy examination. The radiological examination revealed no fracture.

During the external examination, we found a transverse fracture of the two central maxillary incisors and uprooting of the left lateral upper maxillary incisor, with a wound on the upper lip, adjacent to the lesions found in the dental sections (circled in blue in the photograph below).

In the photo to the right, the transverse fracture of the two maxillary central incisors and gingival lesion is shown, with uprooting of the left lateral maxillary incisor and a wound in the upper lip, adjacent to the lesions found in the dental sections.

During the necropsy, as already seen in the radiological examination, the integrity of the skullcap was confirmed, only with hemoglobin infiltration in the anterior and posterior flaps; as well as in the temporal muscle, as can be seen in the photograph to the right.

During the necropsy, as already seen in the radiological examination, it was found that there was no impairment of the spinal column after the anterior dissection of this portion of the spinal column, as can be seen in the photograph to the right.

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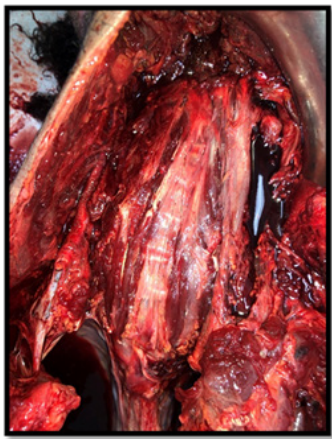
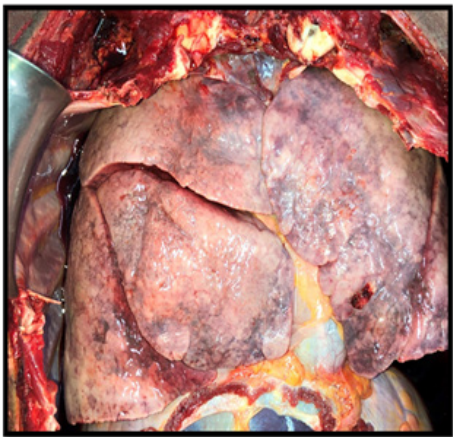


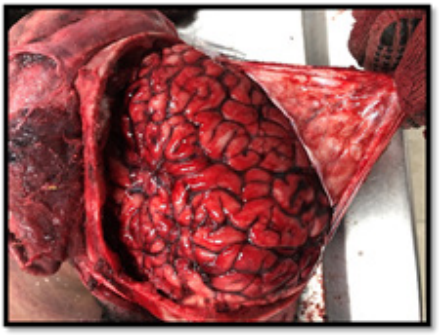
The examination of the lungs did not show any alterations commonly found in cases of drowning in salt water, as can be seen in the photograph to the right.



The examination of the trachea did not show any alteration of the types commonly found in cases of drowning in salt water; only hemoglobin infiltration was detected, as can be seen in the photograph displayed to the right.

Upon opening the skull, it was found that the meningeal spaces contained blood, especially in the subdural space; the brain was swollen, characterized by flattening of the circumvolutions and erasure of the cerebral grooves, especially in the left hemisphere; the cerebral ventricles gave out bloody fluid when the cuts were made; the base of the skull proved to be intact.

In the photograph to the right, we demonstrate the meningeal spaces with blood; the brain was swollen, characterized by flattening of the circumvolutions and erasure of the cerebral sulci, mainly in the left hemisphere.



The relevance of the presentation of this case is initially linked to the importance of the proximity of summer, as already stated by the Brazilian Society of Orthopedics and Traumatology[16,17] (SBOT), with the warning for the population to avoid diving in unfamiliar waters, whether it be in swimming pools, rivers, or the sea, and the unprecedented mechanism of trauma resulting from diving in the sea, traumatizing the face and, consequently, the brain, by mechanisms of deceleration, leading to death, with the submersion of the body, without inhaling water.

Finally, as a last note, to avoid diving accidents, the focus must be on prevention!

In Australia, cervical trauma prevention programs were created that included warning signs, TV commercials and informational posters with the aim of reducing the high rate of accidents resulting in cervical cord injuries. Elsewhere, educational campaigns such as in Germany (TV commercials) and the USA (Think First) are initiatives introduced to reduce the incidence of whiplash injuries. The Feet First, First Time program has had an impact on reducing the incidence of injuries caused by diving in some regions of the USA.

Acknowledgments

None.

Conflicts of interest

The author declares there is no conflict of interest.

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