Electroacupuncture and Intrathecal Transplantation of Heterologous Adipose-derived Mesenchymal Stem Cells for Treating Spinal Cord Injury in a Loggerhead Sea Turtle (*Caretta caretta*)

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The major goal of rehabilitating injured sea turtles is to nurse these animals back to health and release them back into the sea. Sea turtles are vulnerable to most anthropogenic effects, and impact traumas, such as propeller strike and blunt force trauma caused by vessel collision are a common cause of injury and death (Work *et al.* 2010; Denkinger *et al.* 2013). In southeast Florida, for instance, up to 60% of stranded loggerhead turtles exhibit propeller strike injuries (Work *et al.* 2010). In Hawaii, 2.5% of the green turtles found dead on the beaches between 1982 and 2003 had been killed by boat strikes (Chaloupka *et al.* 2008). According to Casale *et al.* (2010) vessel collisions are a major cause of mortality during the warm season in Italian waters. Boat strikes were also reported off the coast of Gabon and contributed to mortality of leatherback turtles (Deem *et al.* 2006). In fact, vessel traffic has been rapidly increasing (Davenport & Davenport 2006) and boat strikes have been reported as a threat for sea turtles in Spain, Italy, Australia, US, Mexico, Gabon and Ecuador (Denkinger *et al.* 2013).

Individuals swimming or feeding at or just beneath the surface of the water are particularly prone to vessel strikes, which can lead to severe lesions, such as carapace fractures, deep cuts, amputations (Denkinger *et al.* 2013) and spinal cord injuries (SCI) (Orós *et al.* 2005). SCI is one of the most severe complications of spine lesions and may cause irreversible damage to neural tissues.

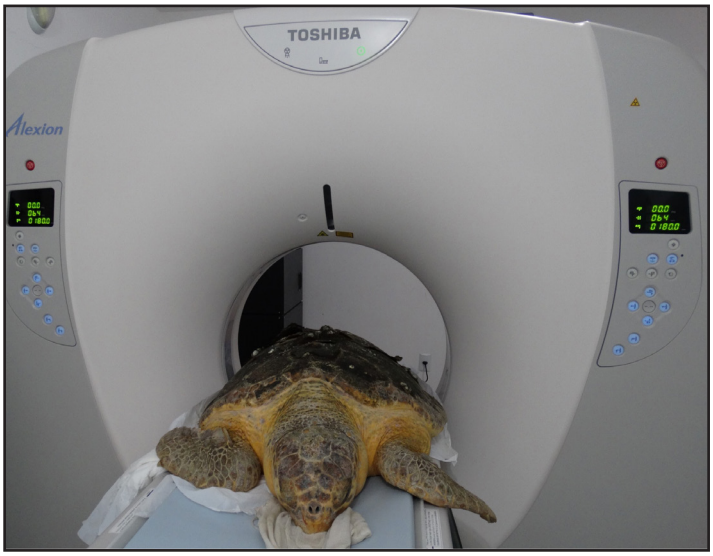

Figure 1. Injured loggerhead undergoes a CT Scan to evaluate the full extent of the damage.

The major challenge in the treatment of SCI is achieving axonal regeneration. Recent studies have demonstrated the therapeutic potential of mesenchymal stem cells (MSCs) associated with electroacupuncture (EA) to treat nervous system diseases, especially due to their regenerative, anti-inflammatory and immunomodulatory properties, modulating the microenvironment and facilitating axonal regeneration (Yang *et al.* 2005; Yan *et al.* 2011). MSCs are undifferentiated stromal cells that can be isolated from different tissues, with the most common sources being the bone marrow and the adipose tissue (Liu *et al.* 2012). MSCs have the potential to differentiate into bone, cartilage, fat, tendon, vascular endothelium and hematopoietic tissues (Rosenbaum *et al.* 2008). On the other hand, EA is a modern type of acupuncture that involves inserting needles and providing stimulation through electric pulses. According to the literature, EA improves the local microenvironment of the spinal cord, reduces edema, induces the repair of neural function and inhibits tissue necrosis (Liu *et al.* 2012). The goal of this study was to isolate and culture adipose tissue stem cells from a healthy loggerhead turtle (*Caretta caretta*), to treat hind flipper paralysis due to a propeller injury, while associating this treatment with electroacupuncture.

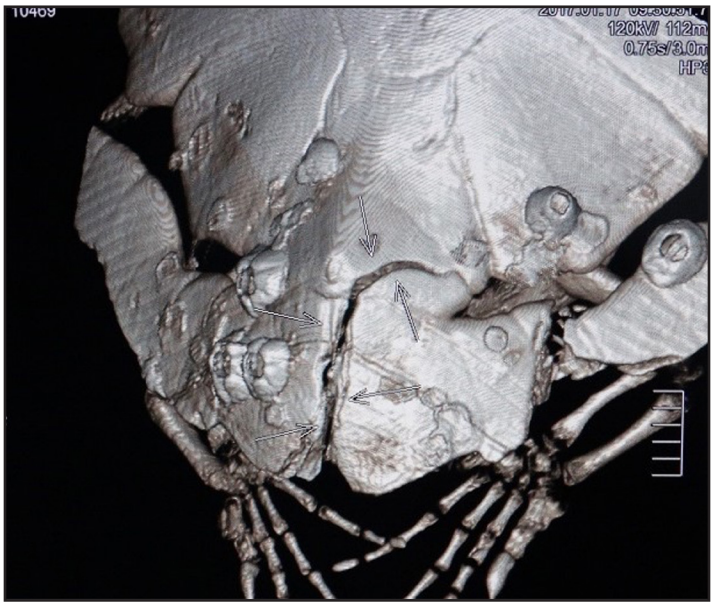

Figure 2. The CT scan reveals a fracture on the caudal part of the carapace (arrows).