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Case Report

MRI Tractography Revealed an Unusual Brainstem Twisting in a Patient who Survived a Severe Traumatic Upper Spinal Dislocation

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Abstract

Introduction: Variety types of traumatic injuries are very common in car accidents in drivers and passengers. Brain injury is very common after a forceful setback or jolt to the head and/or body during a crash. Injuries harm victims who complain of severe cognitive, emotional and physical impairments if they do not die during the accident. Victims' outcome is usually catastrophic when the brainstem is injured.

Diffusion-weighted imaging (DWI) is an MRI methodology recently developed, which allows for visualization and differentiation of gray and white matter *in vivo*.

Case Report: We present a male patient, 39 years old, who was admitted to an emergency hospital in February 2003. The patient had tetraplegia and showed a Glasgow Coma Scale score of 4, complaining of respiratory arrhythmia. After four weeks, the patient was diagnosed with an unresponsive unaware syndrome (UWS). We were able to evaluate the patient in 2010. Then, we diagnosed the patient as being minimally conscious (MCS), because he showed an incomplete but strong indication of environmental awareness, with a reproducible gestural reply after simple commands. He could also show visual pursuit of relatives and other individuals in his room. He still maintained severe tetraplegia, hyperreflexia, and bilateral Babinski sign.

Results: A MRI-T2 hyperintensity was found in the lower part of the medulla oblongata, which suggested an old infarct. It was surely due to an ischemic and/or hemorrhagic injury because of the brainstem compression. MRI-Tractography demonstrated an uncommon brainstem tract twisting. A 3D reconstruction of CT scan slices showed a rotatory distortion of the upper part of the spine.

Discussion: The presence of twisting instead of a brainstem section in MRI-Tractography is a rare neuroimaging result that highpoints the clinical, anatomic, and functional assessment of car accident survivors with severe spinal dislocation and brainstem compression.

Keywords: *MRI Tractography; Brainstem Injury; Brainstem Twisting; Upper Spinal Dislocation*

Introduction

Variety types of traumatic injuries are very common in car accidents in drivers and passengers. Brain injury is very common after a forceful setback or jolt to the head and/or body during a crash. Injuries harm victims who complain of severe cognitive, emotional, and physical impairments if they do not die during the accident. Depending on the brain region damaged during car accidents results in the degree, type, and duration of victims' symptoms and disabilities. Patients' outcomes are usually catastrophic when the brainstem and/or spine are damaged [1-4].

High-resolution magnetic resonance imaging (MRI) is an advantageous technique to visualize the brainstem *in vivo*. Standard clinical MRI scans do not allow a correct visualization of these structures because there is insufficient tissue contrast.

Recently developed diffusion-weighted imaging (DWI) is a non-invasive technique that allows visualization of gray and white matter architecture *in vivo*. DWI tractography can assess white matter pathways based on the water diffusion properties of the primary tissue. DWI tractography can assess white matter pathways based on the water diffusion properties of the primary tissue [5-9].

We aim to describe a patient who, after a car accident, presented an unusual brainstem twisting revealed by MRI tractography.

Materials and Methods

The patient had tetraplegia and showed a Glasgow Coma Scale score of 4, complaining of respiratory arrhythmia. After four weeks, the patient was diagnosed with an unresponsive unaware syndrome (UWS).

We were able to evaluate the patient in 2010. Then, we diagnosed the patient as being minimally conscious (MCS), because he showed an incomplete but strong indication of environmental awareness, with a reproducible gestural reply after simple commands. He could also show visual pursuit of relatives and other individuals in his room [10]. He complained of severe tetraplegia, hyperreflexia and bilateral Babinski sign.

Results

Following our protocols for neuroimaging studies, aA MRI-T2 hyperintensity was found in the lower part of the medulla oblongata, which suggested an old infarct. It was surely due to an ischemic and/or hemorrhagic injury because of the brainstem compression [1,2]. MRI-Tractography demonstrated an uncommon brainstem tract twisting. A 3D reconstruction of CT scan slices showed a rotatory distortion of the upper part of the spine.

Discussion and Conclusion

Our patient suffered a cardiac arrest at the accident scene, where he was reanimated. The duration of cardiac arrest with no cerebral blood flow arrest was undetermined. The patient arrived at the hospital in a critical condition requiring life support and critical care, which hampered the upper spinal dislocation finding, and resulted in a lack of an early radiological sign [4,11-13].

The brainstem is a crucial nervous system structure that sustains survival functions. These functions are cardiovascular and respiration regulation, sleep cycles, consciousness, and sensory-motor communication between the brain and the spinal cord. The brainstem is anatomically and functionally complex, with many gray nuclei and short and long white matter networks connecting the spine and supratentorial structures [14,15].

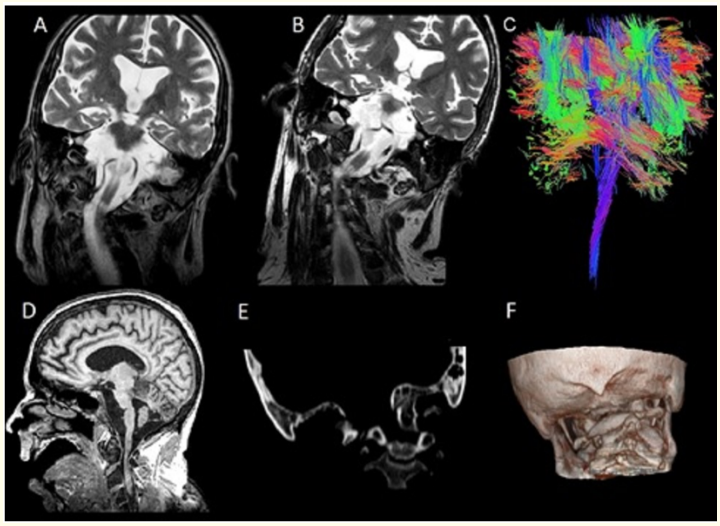

Figure 1: *A-B: MRI (T2, coronal view), shows brainstem deformity and T2 hyperintensity in the lower part of the medulla oblongata suggesting the presence of an old infarct. C: Tractography reveals twisting of long tracts along the brainstem. D: MRI (T1, sagittal view) showed severe atrophy of the brainstem. E-F: CT-3D showing a rotatory upper spine dislocation.*

We conclude that MRI-Tractography may provide valuable insights about white matter organization within the brainstem *in vivo*. Hence, this is a powerful tool to explore the organization of white matter in the brainstem, spine, and the rest of the nervous system [5-9].

The presence of twisting instead of a brainstem section in MRI-Tractography is a rare neuroimaging result that highpoints the clinical, anatomic, and functional assessment of car accident survivors with severe spinal dislocation and brainstem compression.

Statement of Ethics

Our research followed the guidelines for human studies following the World Medical Association Declaration of Helsinki.

This study protocol was reviewed and approved by the Ethical and Scientific Committee of the Institute of Neurology and Neurosurgery, Havana, Cuba.

Consent to Publish Statement

Our principal investigator obtained signed informed consent from the patient's father, although the patient's name was not revealed.

Conflict of Interest Statement

The authors declare no conflict of interest.

Author Contributions

Calixto Machado (First and Corresponding Author): Substantial contributions to the conception or design of the work and the acquisition, analysis, or interpretation of data for the work. Drafting the work or revising it critically for important intellectual content. Final approval of the version to be published.

Jesus Perez-Nellar and Rafael Rodríguez-Rojas: Substantial contributions to the conception or design of the work and the acquisition, analysis, or interpretation of data for the work. Final approval of the version to be published.

Mauricio Chinchilla, Yanin Machado, Arthur Schift: Final approval of the version to be published.

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