

Reconstruction of the Ascending Reticular Activating System with Diffusion Tensor Tractography in Patients with a Disorder of Consciousness after Traumatic Brain Injury

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Abstract

This work describes the reconstruction of the ascending reticular activating system (ARAS) with diffusion tensor tractography in three patients with altered consciousness after traumatic brain injury. A diffusion tensor tractography was performed in three patients with impaired consciousness after a severe traumatic brain injury. A 1.5 T scanner was used to obtain the tensor sequences; axial tensors were acquired. Post-processing was performed, and the mean fractional anisotropy (FA) values were recorded. The FA maps were used to do a manual tracing of the following regions of interest (ROIs): the ventromedial midbrain, the anterior thalamus, and the hypothalamus. Case 1 presented destruction of the right dorsal and ventral tegmental tracts as well as destruction of the right middle forebrain bundle, case 2 had destruction of the right dorsal tegmental tract, and case 3 had destruction of the bilateral ventral and dorsal tegmental tracts, as well as destruction of the right middle forebrain bundle. The affected fibers of the ascending reticular activating system with diffuse axonal injury and the FA values abnormalities in the ascending reticular activating system in three patients with a disorder of consciousness (DOC) after traumatic brain injury are described.

Categories: Neurosurgery

Keywords: diffusion tensor imaging, arousal, consciousness, ascending reticular activating system, tractography, traumatic brain injury, neurosurgery

Introduction

The arousal component of the consciousness is generated by the ascending reticular activating system (ARAS) [1]. It has been largely demonstrated that the ARAS is composed of groups of neurons that project from different nuclei in the brainstem forming a diffuse and complex network that connect to the cortex through thalamic and extra-thalamic pathways. The ARAS integrates its reticular core and its nuclei in the brainstem, as well as its rostral projections directed to the hypothalamus, the thalamus, the basal forebrain, and the cortex [1]. After the development of diffusion tensor imaging (DTI) and fiber tracking post-processing, the neuroanatomic connectivity of the ARAS and its relationship with altered consciousness disorders were carefully described [1]. Description of the ARAS in healthy subjects and in post-mortem formalin brains [1-2] have been reported, as well as some cases with diffuse axonal injury (DAI) after traumatic brain injury (TBI) [3-4]. Analysis of fractional anisotropy (FA) values of white matter tracts in patients after anoxic brain injury [5] and patients after TBI [4] have been performed and a DTI prediction system for long-term neurological outcome in comatose patients has also been reported [6]. The objective of this manuscript is to describe the reconstruction of diffusion tensor tractography (DTT) of the ARAS pathways in three patients with impaired consciousness after TBI.

Case Presentation

Patients and definitions

Clinical and neuroimaging data of three Hispanic male patients with severe TBI, with a disorder of consciousness (DOC) following trauma, admitted at the intensive care unit (ICU) of the Hospital Infantil Universitario de San José, Bogota, Colombia, between January 2015 and January 2017 are presented. The

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