IJAE
Vol. 120, n. 1 (Supplement): 161, 2015
ITALIAN JOURNAL OF ANATOMY AND EMBRYOLOGY

Advances from probabilistic tractography in connections of the limbic system with the cerebellum

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The limbic system is a complex set of brain structures located on both sides of the thalamus, right under the cerebrum. It is not a separate system but a collection of structures from the telencephalon, diencephalon, and mesencephalon, including the hippocampus, amygdala, anterior thalamic nuclei, fornix, columns of fornix, mammillary body, septum pellucidum, habenular commissure, cingulate gyrus, parahippocampal gyrus, limbic cortex, pars of olfactory system and limbic midbrain areas. Nevertheless, recent studies showed that the definition of anatomical structures considered part of the limbic system is a controversial subject.

Although the role of the cerebellum was traditionally considered mainly associated to motion control, it has been recently suggested a cerebellar involvement in emotions control, cognitive processes and social behavior. In this regard, we have previously demonstrated that the cerebellum is interconnected with the hippocampus [1].

In this work, a wider sample of normal subjects was examined by using probabilistic Constrained Spherical Deconvolution (CSD) tractography, which represents a method able to overcome many limitations of other Diffusion Tensor Imaging (DTI) techniques, providing more accurate data [2]. We found evidences in the human brain that the cerebellum is widely linked with limbic-related structures and provided a more reliable demonstration of direct cerebello-limbic pathways.

In addition, we further extendend our analysis to the other limbic connections including uncinated fasciculus, cingulate fasciculus, inferior longitudinal fasciculus, anterior thalamic connections and fornix. Although these pathways have been already described in the tractographic literature we provided reconstruction and quantitative analysis, which could be potentially useful to explore pathological conditions damaging this system.

Finally, the demonstration of the existence of cerebello-limbic connections could constitute an important step in the knowledge of the anatomic substrate of non-motor cerebellar functions.

References

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Keywords

Cerebellum; cerebello-limbic connections; CSD; probabilistic tractography.

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