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Neuroanatomical features of the Locus Coeruleus in neurodegeneration

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The nucleus Locus Coeruleus (LC) is placed in the upper part of the pons, is mainly formed by medium-sized neurons containing neuromelanin and it is part of the so-called isodendritic core of the brain stem reticular formation. LC is the main source of noradrenaline in the brain. In humans, each one of two symmetrical LC nuclei is formed by up to 60.000 neurons, which send axons profusely branching and innervating the entire cerebral and cerebellar cortices. Noradrenaline is released through "bouton en passage" by LC axons, and thus it modulates the activity of several cortical areas. In particular, LC modulates sleep/wake cycle, different cognitive functions (such as attention, alerting and novelty orienting and memory consolidation) and electroencephalogram activity. It also plays an important role in neural plasticity and neuroprotection.

Several post-mortem studies showed a significant LC cell loss in Parkinson's Disease (PD) and in cases of severe Alzheimer's Disease (AD) dementia, in post-mortem studies.

Recent histological data suggest a very early involvement of LC in the pathogenesis of AD. In particular accumulation of phospho-tau deposits in the axons of LC neurons may precede their occurrence in limbic regions in Mild Cognitive Impairment (MCI, which is the prodromal phase of Dementia) or even in pre-MCI stages. Experimental data show that LC impairment may accelerate beta amyloid plaques deposition and neuroinflammation.

Recently, specific 1,5 and 3,0 Tesla Magnetic Resonance Imaging (MRI) protocols and post-processing analysis have been developed in order to detect neuromelanin-containing LC neurons in vivo in controls and in PD patients, as well as in dementia. In this presentation, we report the state of the art of the neuroanatomical features of LC in models of degenerative diseases, as well as more recent evidence in humans. These data disclose a novel scenario for LC, stemming from in vivo neuroanatomy to neurobiology of neurodegenerative diseases.

Key words

Neurodegenerative diseases, noradrenaline, neuromelanin.