Senescence, prodromal dementia, electrophysiological biomarkers.

Juliana Dushanova

Institute of Neurobiology, Bulgarian Academy of Sciences, Sofia, Bulgaria.

Accepted October 21, 2016

Dementia in the elderly is described by symptoms of attentional deficits, memory impairments, executive dysfunction and cognitive decline. In several major neurodegenerative disorders is occurred dementia. Fronto-temporal dementia and hippocampal sclerosis of aging, Lewy body dementia, non-Alzheimer's form as vascular dementia and Alzheimer's disease, which vary between brain regions like the hippocampus, entorhinal cortex, medial temporal lobe, inferior parietal cortex and frontal cortex, may explain a magnitude of deficits in different cognitive domains [1-5]. Preservation of cognitive function is important for maintenance of the quality of life of older adults.

Through support and maximizing personal strengths in partnership with the physicians, understanding as much as possible about dementia, medications, and non-drug therapies, the life will continue to have meaning and richness for affected by dementia people, who can participate in the health-care decisions that uniquely affect them.

The pathological hallmarks of dementia, like Lewy bodies and Parkinson disease dementia with neuronal loss in a substantia nigra, noradrenergic neurons in the locus ceruleus, serotonergic neurons in raphe nuclei, and cholinergic neurons in the basal nucleus of Meynert, are exhibited in approximately 15% of people older than 60 years. The quality of life is affected in patients with mild cognitive deficits because they have a higher risk of developing dementia. It is well known that dementia can occur at any time point in Parkinson disease, and parkinsonism at any time point in Lewy body dementia [1,5]. The progress of cognitive deficits may delay or even the development of dementia can prevent when the interventions are applied in early stages of cognitive decline.

With the support of a multidisciplinary training program on cognitive function, patients with mild cognitive deficits manage their daily life better and become more self-confident [1]. First symptoms are very mild and intermittent. Physical training activity improves cognitive functions of patients with cognitive problems. Their sports activity has social aspects because involves their partners and prevent the patient's depression and the social isolation, which are closely associated with cognitive decline. Both motor and cognitive impairments in people with Lewy bodies and Parkinson disease dementia can be improved by long-term multimodal exercise programs which could have a broader impact on quality of life than specific exercise interventions. Thus, individuals, who are in the preclinical phase of dementia and have an urgent need for early treatment to slow down or stop the disease progression, are screening by new developing imaging modality for earlier diagnosis of the disease.

The first recognized functional imaging features distinguishing dementia with Lewy bodies from Alzheimer's disease are the occipital features, but the additional features are the posterior cingulate island sign and relative sparing of mesio-temporal lobe activity in dementia with Lewy bodies compared to Alzheimer's disease. The olfactory bulb, amygdala, hypothalamus, mesopontine tegmentum, and dorsal motor nucleus of the vagus are especially vulnerable to Lewy body pathology. Involvement of the allocortex and the anterior temporal neocortex is characteristic of dementia with Lewy bodies and Parkinson disease dementia. Alzheimer-type neurofibrillary degeneration composed of tau protein is variable in dementia with Lewy bodies and Parkinson disease dementia. Clinical challenge is a determination of the contributions of multiple pathologies to the dementia syndrome, which needs from imaging biomarkers to detect the presence of related to the Lewy bodies and Alzheimer's disease pathologies and following their progression [2-4].

In recent years, the early diagnosis relatedly to mild cognitive impairment and prodromal dementia are in the basis of the increasing attention of the scientists. The early diagnosis of the predementia stage of cognitive decline which culminates in Dementia with Lewy bodies includes the use of imaging biomarkers [5]. The time course temporal dynamics characterize the cognitive functions. The human cognition from simple event perception to higher cognitive processes, such as planning or decision making is influenced by the efficiency of time-related information processing. For the efficiency of human cognition is crucial the relationship between temporal information processing in a millisecond time domain and cognitive functions. A decline of the temporal information processing accompanies age-related deterioration of many cognitive functions. One potential biomarker modality which has previously been neglected in Dementia with Lewy bodies is that of electrophysiology, which includes approaches such as electroencephalography (EEG), magnetoencephalography [6-8]. A barrier to the use of electrophysiological techniques such as EEG in dementia studies for both clinical and research-wise has been their lack of diagnostic specificity and the tendency for the use of neuroimaging. Complex multimodal electrophysiological approaches may help to understand the pathoetiological basis of dementia [8].

A convenient indicator of cortical dysfunction in dementia, which could be used to classify some idiopathic dementias,

are Event-related potentials (ERPs) and particular time domain frequency oscillations of the EEG, which correlate to the degree of cognitive impairment in specific diseases. Determining the age pathologic correlates of imaging findings is critical for diagnosis and treatment planning in patients with prodromal dementia. Studies, providing a reliable estimate of the effects of aging on ERP components in active auditory oddball tasks, allow comparison between ERP waves from early sensory to late cognitive components [7,9]. Indices of the sensory processing stages as amplitudes of components N1 and P2, which increase with age and especially N1 lag, show an age-related decline in the ability to withdraw attentional resources from the sensory stimuli. This effect is more pronounced in the frontal brain regions as they are most affected by aging. The early cognitive component N2 delays all over the scalp and frontally attenuates in elderly subjects. The late cognitive component P3 diminishes and delays with the age in both auditory and visual paradigms and its scalp distribution alters potential field shifts to frontal regions. High-tone stimulation and movement requirements lead to a delay of ERP-components in elderly subjects and their amplitudes diminish with increasing age.

Whether the contribution of specific frequency band responses to the stability of sensory/cognitive mechanisms accompanying aging or to the pathological cortical aged dysfunction in dementia is still an inconclusive question. Some idiopathic dementias are classified as specific diseases by means of peculiar frequency oscillations that occur within affected brain regions [1,6]. Identifying the effects of aging on the specific stages of information processing in the cortical low- and high-frequency domain, we could relate the more pronounced frequency patterns with poorer cognitive abilities with advancing age during an auditory discrimination task [10,11]. The amplitudes of β2 (beta β2: 20.5–30 Hz), γ (gamma γ1: 30.5–49; γ2: 52–69 Hz) and low-frequency activity (delta δ: 2–4, theta θ: 4.5–7, alpha α: 7.5–12 Hz) are more pronounced with progressive age, but β1-component (beta β1: 12.5–20 Hz) is less affected by age during sensory processing. The age difference with respect to scalp distribution is tone-independent for δ/θ, but not for α-activity. Age- and tone-dependent α-changes are focused on frontal and sensorimotor areas. The low- and high-frequency amplitudes during cognitive processing diminish with increasing age, except for frontal β2 and γ high-tone responses, while β1-activity is more widespread than during sensory processing. This age difference increases in fronto–parietal direction more expressed after high-tone stimulation. The age influences more the cognitive processes than the sensory ones.

A useful tool for detecting subtle abnormalities of the cognitive processes in the central nervous system of patients with Parkinson disease dementia are brain event-related oscillations [1,6]. Deviations of the auditory and visual elicited brain oscillatory responses at specific frequencies are an evidence for disturbances in the temporal and regional integration of these frequency components and related to them relationships between cortical and the basal ganglia circuits in parkinsonism. It is likely that such biomarkers will be important in identifying and defining prodromal dementia.

References

1. Dushanova J. Diagnostics, rehabilitation and models of Parkinson's disease Health. 2012; 4: 1200-1217.
2. Mak E, Su L, Williams GB, O'Brien JT. Neuroimaging characteristics of dementia with Lewy bodies. Alzheimers Res Ther 2014; 6: 1-18.
3. Lowther ER, O'Brien JT, Firbank MJ, Blamire AM. Lewy body compared with Alzheimer dementia is associated with decreased functional connectivity in resting state networks Psychiatry Res 2014; 223: 192-201.
4. Raman MR, Schwarz CG, Murray ME, Lowe VJ, Dickson DW, Jack CR Jr, Kantarci K. An MRI-Based Atlas for Correlation of Imaging and Pathologic Findings in Alzheimer's Disease. J Neuroimaging 2016; 26: 264-268.
5. Mak E, Su L, Williams GB, Firbank MJ, Lawson RA, Yarnall AJ,… Duncan GW. Baseline and longitudinal grey matter changes in newly diagnosed Parkinson's disease: ICICLE-PD study Brain 2015; 138(10): 2974-2986.
6. Dushanova J. Pathological Changes of Event-Related Brain Oscillations in Parkinson's Disease book: Horizons in Neuroscience Research Editors: Andres Costa and Eugenio Villalba. Nova Publishing 2014; 15: 1-41.
7. Nowak K, Oron A, Szymaszek A, Leminen M, Naatanen R, Szelag E. Electrophysiological Indicators of the Age-Related Deterioration in the Sensitivity to Auditory Duration Deviance Front Aging Neurosci 2014; 22: 1-10.
8. Colloby SJ, Cromarty RA, Peraza LR, Johnsen K, Johannesson G, Bonanni L, Onofrj M. Multimodal EEG-MRI in the differential diagnosis of Alzheimer's disease and dementia with Lewy bodies J Psychiatr Res 2016; 78: 48-55.
9. Christov M, Dushanova J. Functional correlates of the aging brain: beta frequency band responses to age-related cortical changes. Int J Neurorehabilitation 2016; 3: 1-6.
10. Dushanova J, Christov M. The effect of aging on EEG brain oscillations related to sensory and sensorimotor functions. Adv Med Sci 2014; 59: 61-67.
11. Christov M, Dushanova J. Functional correlates of brain aging: beta and gamma frequency band responses to age-related cortical changes. Acta Neurobiol Exp 2016; 76: 97-108.

*Correspondence to:

Juliana Dushanova
Institute of Neurobiology
Bulgarian Academy of Sciences, Sofia
Bulgaria