NARRATIVE ARTICLE

Prevention/delay of Alzheimer's Disease by Vestibular Stimulation: A Hypothesis

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ABSTRACT

Alzheimer's disease (AD) is characterized by a progressive decline in the cognitive functions, usually starting with memory complaints and eventually progressing to involve multiple cognitive, neuropsychological, and behavioral domains. Here, we review the possible mechanisms by which vestibular stimulation may prevent or delay AD. The current article establishes the hypothesis for the use of vestibular stimulation for the management of Alzheimer's. We recommend translational research in this area to provide experimental evidence to support the use of vestibular stimulation.

KEY WORDS: Alzheimer's disease, hypothesis, translational research, vestibular stimulation.

Introduction

Alzheimer's disease (AD) is characterized by a progressive decline in the cognitive functions, usually starting with memory complaints and eventually progressing to involve multiple cognitive, neuropsychological, and behavioral domains.[1] Physiological changes that occur during a normal ageing of the brain may exacerbate and initiate pathological processes that may lead to neurodegenerative disorders, especially AD. Hence, the risk of AD rises exponentially with age.[2] The definitive diagnosis of AD comes from postmortem analysis of the neuropathological changes in the brain. Analyses of both clinical and pathological features, i.e., clinic-pathological correlation studies have provided important insights into how the pathology correlates with cognitive status AD is characterized by the abnormal deposition of amyloid β peptide, and intracellular accumulation of neurofibrillary tangles of hyperphosphorylated τ protein and dementia. However, these phenomena are mainly initiated and enhanced by oxidative stress, a process referring to an imbalance between antioxidants and oxidants in favor of oxidants.[3] To discover an alternative therapy with minimum or less side effects to delay or prevent AD is prime important as AD burdens an increasing number of our nation's elders and their families.

Earlier research reported that there is a close association between the vestibular system and spatial memories constructed by areas of the brain such as the hippocampus.[4,5] While many animal studies have been conducted which support this relationship, there is substantial evidence that vestibular loss also causes cognitive disorders; some of which may be due to the reflexive deficits and some of which are related to the role that ascending vestibular pathways to the limbic system and neocortex play in spatial orientation.[6]

The well-known functions of the vestibular system are regulation of equilibrium and posture. However, the vestibular system is having extensive connections with hippocampus, raphe nucleus, locus coeruleus, thalamus, amygdale, insular cortex, anterior cingulated cortex, cerebellum, occipital cortex, putamen, parietal lobe, and other areas of the brain which plays a key role in cognitive process.[7] So controlled, vestibular stimulation do

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Quick Response Code:

Website: www.jmsh.ac.in

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have positive effects on memory and learning, stress relief, improving sleep quality, and immunity.[8] Vestibular stimulation triggers a range of changes in cognition, emotions, and personality through controlling autonomic functions. For AD, only temporary treatments are available but with a lot of side effects.[9] Hence, there is a need of alternative therapy which can potentiate improvement and with less or without side effects. Vestibular stimulation is a physiological approach to the management of cognitive disorders. The emerging evidence proves that activation of the vestibular system, by different methods of vestibular stimulation is beneficial in the improvement of spatial and verbal memory.[10] However, as many types of vestibular stimulation methods are available, it is essential to explore the efficiency of different types of vestibular stimulation in improving memory and learning. Here, we review different possible mechanisms through which vestibular stimulation may prevent/delay AD.

What are the Possible Causes of AD?

Although the causes of Alzheimer's are not yet fully understood, it was believed that AD is caused by a combination of genetic, lifestyle and environmental factors that affect the brain over time.[10] The risk factors include ageing, family history and genetics, down syndrome (DS), mild cognitive impairment, unhygienic lifestyle, high blood pressure, high cholesterol and obesity, poorly controlled Type 2 diabetes.[10] Age is considered to be the main risk factor as the number of sufferers doubles every 5 years beyond age 65.[10]

How Vestibular Stimulation Prevents/delays AD?

Vestibular stimulation prevents/delays AD by influencing brain ageing

Ageing effects different brain areas to different extent.[11] Further, these changes vary in males and females with frontal and temporal lobes most affected in males, compared with the hippocampus and parietal lobes in females.[12,13] Altered secretion of the important neurotransmitter of ageing; serotonin increases the vulnerability to psychiatric and neurodegenerative disorders.[14] Vestibular stimulation was found to delay brain ageing and by preventing age-related changes in serotonin secretion.[15]

Vestibular stimulation prevents/delays AD by regulating food intake

Cardiovascular abnormalities are closely associated with obesity: Contributes AD.[16] The vestibular system prevents obesity by regulating food intake through its extensive interactions with hypothalamus, dorsal raphe nucleus, nucleus tractus solitarius, locus coeruleus, and hippocampal formation.[17] Animal studies provide evidence for anti-hyperlipidemic effect of vestibular stimulation.[18]

Vestibular stimulation prevents/delays AD by prevent/delay hypertension

Hypertension has been related to pathological manifestations of AD such as senile plaques, neurofibrillary tangles, and hippocampal atrophy.[19] Hypertension causes cerebrovascular disease which may increase the risk of AD.[20] Vestibular stimulation regulates autonomic functions[21-25] and results in regulation of blood pressure within normal limits.

Vestibular stimulation prevents/delays AD by preventing hippocampus atrophy

Atrophy of hippocampus was reported as a key feature of AD.[26] Anatomical connections exist between vestibular system and hippocampus[27] and vestibular stimulation activates hippocampus.[28] Interestingly, bilateral loss of vestibular function is associated with a significant bilateral atrophy of the hippocampus.[29] Hence, normal functioning of hippocampus requires connections with vestibular system. Further, vestibular stimulation modulates spatial processing and place cell firing and facilitates long-term potentiation in the hippocampus by increasing acetylcholine release in hippocampus.[30,31]

Vestibular stimulation prevents/delays AD by prevent/delay DS

Individuals with DS may have increased the risk for cognitive decline, dementia, and AD.[32] Vestibular stimulation is one of the effective therapy used in the management of DS.[33] Programmed vestibular stimulation decreased heart rate within normal limits in children with DS.[34]

Vestibular stimulation prevents/delays AD by management of diabetes mellitus (DM)

Diabetes observed in AD may be called as "Type 3" diabetes" as it selectively involves the brain and has molecular and biochemical features that overlap with both Type 1 DM (T1DM) and T2DM.[35] Vestibular stimulation not only as a potential intervention to prevent or delay the development of DM in at-risk population but also to use it as supplementary therapy for diabetic patients management.[36] Animal and human

studies recommended vestibular stimulation for management of DM.[37]

Vestibular stimulation prevents/delays AD by promoting sleep

It was reported that sleep and circadian rhythms might impact Alzheimer's pathogenesis.[38] The vestibular system is having extensive interactions with hypothalamus, dorsal raphe nucleus, nucleus tractus solitarius, locus coeruleus, hippocampal formation, and promotes sleep. Vestibular stimulation promotes sleep by relieving pain and reducing stress. Vestibular stimulation also promotes sleep by regulating growth hormone and thyroid hormones.[39]

Conclusion

The current article establishes the hypothesis for the use of vestibular stimulation for the management of Alzheimer's. We recommend researchers to start translational research in this area to provide experimental evidence to support the use of vestibular stimulation.

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Financial Support: None; **Conflict of Interest:** None

How to cite this article: Archana R, Sailesh KS, Abraham J, Mishra S, Reddy UK, Mukkadan JK. Prevention/delay of Alzheimer's disease by vestibular stimulation: A hypothesis. J Med Sci Health 2016;2(3):30-33.

Date of submission: 06-05-2016
Date of peer review: 12-07-2016
Date of acceptance: 18-08-2016
Date of publishing: 20-10-2016