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Tooth Loss and Chewing Dysfunction as Modifiable Risk Factors for Dementia

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ABSTRACT

The population of the world is growing and people are living longer. Today 32 % of the population is over the age of 60 and 46.8 million people worldwide have cognitive impairment or dementia [1]. This is a serious challenge in healthcare. Reducing risk factors for developing dementia is crucial and recent studies have identified that tooth loss and mastication or chewing dysfunction have been associated with cognitive decline [1]. Research has demonstrated that effective chewing maintains hippocampus-dependent cognitive function by increasing cerebral cortical blood flow necessary for learning, memory, and for hippocampal cell neurogenesis [2,3]. Tooth loss is also a source of chronic stress and involves the hypothalamic-pituitary-adrenal (HPA) axis that increases circulating corticosterone associated with spatial learning deficits [4]. Additionally, tooth loss affects the trigeminal sensory pathway that is linked to learning and memory [4]. The following is a discussion of tooth loss and its effect on cognition. These are important and surprising findings that present as modifiable risk factors that can impact the quality of life for the geriatric population.

Keywords

Cognition, Mastication, Tooth loss.

Risk Factors for Dementia

Dementia is often seen as a natural consequence of aging, but current research reveals otherwise. While there are known non-modifiable risk factors such as age, being female, and having a genetic predisposition, it is also known there are a growing number of modifiable risk factors. These include smoking, depression, alcohol use, poor diet, diabetes, lack of exercise, isolation, and hearing loss [5]. Surprising research has identified two additional important modifiable risk factors: tooth loss and chewing dysfunction [5]. Reducing risk factors can have a tremendous impact on the prevalence of dementia, such as Alzheimer's disease. Barnes and Yaffe (2011) calculate that half of Alzheimer's cases are due to these risk factors [6]. They project that lifestyle changes and risk factor reduction can prevent millions of cases of Alzheimer's disease worldwide [6].

Mastication and Circulation in the Brain

Dementia is an umbrella term for a group of degenerative neurocognitive disorders. The three most common of these disorders are Alzheimer's, vascular dementia, and Lewy Body dementia [5]. A common denominator among all the dementias is a breakdown of blood circulation in the brain, but the source is different. Reduced blood flow from mastication dysfunction is different than vascular dementia from cardiovascular disease. Furthermore, reduced blood flow has been found to occur early before the development of the plaques and tangles of Alzheimer's that has led to the vascular hypothesis as a cause of the disease [7]. Understanding that mastication dysfunction affects circulation to the brain that can lead to cognitive decline is critical. Identifying this risk factor early can help preserve cognitive function.

Imaging studies such as functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) show that involvement of the stomatognathic axis during mastication increases blood flow to various brain structures that are important in memory and learning [8,9,10]. The first area of the brain damaged by Alzheimer's disease is the hippocampus [11]. It is important in short and long- term memory, and in spatial memory [2,8,12]. Also, severe damage results in anterograde amnesia and the inability to make new memories [8]. Neurogenesis occurs in the hippocampus and cell growth depends on the activity of the masticatory muscles to deliver oxygen and glucose [10,12]. Additionally, mastication dysfunction has been found to decrease brain-derived neurotrophic factor (BDNF) in the hippocampus. This is an important protein molecule involved with neurogenesis, memory and learning [2,13,14].

The prefrontal cortex (PFC) relies on blood flow from mastication. Insufficient nourishment results in impaired executive functioning and poor problem solving [8]. Current research supports there is also mastication -induced arousal that increases blood glucose levels in the PFC that are necessary for cognition [10]. Multiple studies have examined the effects of gum chewing on memory in older adults and found an increase in blood oxygen levels in both the hippocampus and PFC with improvement in working memory tasks [4,8,9].

New findings in neuroimaging suggest that the cerebellum plays an interesting role in mastication. Typically, tooth loss, saliva production and bite force are associated with masticatory ability, but this is also a function of the central nervous system [15,16,17]. Chewing rhythmicity and automatic movement is regulated by the cerebellum and in older adults, efficacy in this highly coordinated system is associated with larger grey matter volume at the premotor cortex [11,15,16]. Studies also found the timing of glossomandibular movement is orchestrated by the cerebellum and depends on proprioceptive input such as hardness and size of food, both of which are determined by masticatory ability [16,18]. Mastication in turn serves to increase blood flow to the cerebellum that is necessary to maintain this cognitive and motor function effectively and prevent cerebellum atrophy [19].

Occlusal Disharmony and HPA Axis

Chewing and mastication dysfunction can be caused by occlusal disharmony. This occurs when the teeth are too long, too short, mal-positioned, or there is a change in the force of the bite. Multiple studies using rodents and monkeys have been conducted to mimic stress in the stomatognathic system by raising the bite with acrylic caps, lowering the bite by shaving or removing teeth [8,10,19]. Researchers found that chronic stress produced by occlusal disharmony activated the hypothalamic-pituitary-adrenal (HPA) axis and increased plasma corticosterone levels [19,20]. This impaired the negative feedback system in the hippocampus which further increased the secretion of corticosterone resulting in cell death, spatial learning deficits, and memory impairment similar to those found in dementia [8]. Correcting the occlusal disharmony resulted in a return to normal corticosterone levels [20]. This logically suggests that when there is normal occlusion, mastication serves to maintain memory and learning [20].

Mastication and the Trigeminal Nerve

The trigeminal nerve is the is the fifth and largest of the cranial nerves. It is composed of two types of fibers that relate to the muscles of mastication and sensory fibers for the face. This nerve is essential in dentistry due to the maxillary and mandibular divisions that supply sensation to the upper and lower teeth [21]. Mastication dysfunction and tooth loss reduce sensory input to the trigeminal nerve [12]. A massive amount of sensorimotor input is received from the teeth and oral cavity through the trigeminal pathway to multiple brain structures necessary for attention, perception, and conscious learning [12]. Research also reveals that this lack of sensory input reduces neurogenesis at the hippocampus resulting in impaired cognitive functioning [12].

Conclusion

Life expectancy has increased dramatically in the 21st century and reducing risk factors for dementia should be a high priority. Mastication dysfunction and tooth loss have been found to play a significant part in cognitive decline and are modifiable risk factors in developing dementia. There is both an emotional and socioeconomic burden of dementia that is a growing concern. This discussion is to increase awareness of the importance of dental health care among all age groups but specifically to target the older population. Preserving cognitive function throughout the life span is essential to the health and well- being of all and can begin with prevention.

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