

Mini Review

Dementia and Masticatory Function: Are They Related?

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Elderly population is increasing at a fast pace, and one of the major problems in this population is the development of dementia, neurodegenerative disease that manifests in alteration of the cognitive function, affecting the daily activity of these patients. Patients with dementia present deteriorated oral health that may affect nutritional intake, thus increasing the risk for dementia. Mild memory impairment is also a risk factor for the development of dementia and Alzheimer's disease. It has been suggested that mastication is associated with cognitive function, including dementia, in older population. Considering these points, the objective of the present mini review is to address the relationship between dementia and the masticatory function. It is possible that attenuation of masticatory performance decreases the cognitive function and cerebral activity, leading to an increased risk for development of dementia and Alzheimer's disease in the elderly population. Proper evaluation of oral health and function may play an important role in the management of this neurodegenerative disease, so it is necessary further studies in this field.

Keywords: Mastication; Tooth loss; Aged, Alzheimer Disease (AD); Cognition

Introduction

Elderly population is increasing rapidly, and, by now there would be more people aged 65 or older, than children under age 5 [1]. Older population have increased risk of developing dementia and Alzheimer's Disease (AD), which is a major global health concern, as nearly 150 million people will develop dementia by the year 2050 [2-4]. Although there is no cure for this illness, symptoms can be managed with proper care [4]. Lifestyle and comorbidities are associated with the development of dementia, usually starting in people over 65 years-old [4,5].

Dementia is a neurodegenerative disease that presents cognitive function impairment that decreases continuously, affecting the daily life of these patients [6,7]. As treatment is basically oriented to alleviate symptoms and prevent further deterioration, identifying the risk factors for dementia is a good option to reduce the prevalence and magnitude of the disease [7].

Mild memory impairment has been addressed as a high risk for dementia, including AD [8]. It has also been suggested that mastication is important for proper cognitive function [9,10]. Loss of teeth is also associated with risk of cognitive function impairment and dementia [11-13]. Considering, this, it is very important to care for the oral health and function in these patients,

Although people are paying attention in oral health and oral function in patients with dementia and AD, there are not many reviews in this topic. Considering this, the objective of the present mini review is to address the relationship between dementia and the masticatory function.

Oral Health in Patients with Dementia

Old patients with dementia present a deteriorated oral health, together with increased number of retained dental roots, root caries

and coronal caries, compared with older patients without dementia, as motor skills and cognition are affected by dementia [14]. The most common type of dementia is AD, and these patients present a decrease in submandibular saliva flow rates, which may be one of the factors that affect their general oral health [15].

It has been reported that presence of dementia and AD is associated with fewer teeth, especially in patients that do not wear dentures. This absence and distribution of teeth may alter the eating ability, by decreasing their food choices, thus leading to a nutritional deficits as well, increasing the risk of developing dementia. [12,16] smaller mouth opening and increased degree of tooth wear are also present in patients with dementia [14]. Tooth loss has been associated with dementia and AD, and one etiological factor for tooth loss is periodontal disease [17,18]. It has been implied that the proinflammatory molecules from tissue with periodontal disease, the pathogens implied and their products migrate through the bloodstream to the brain, increasing the risk for the development of AD [19,20]. Porphyromonas gingivalis, a pathogen involved in chronic periodontitis, and gingipains, its secreted proteases, have been associated to the pathogenesis of AD, as they were present in the brain of these patients [21].

Role of Mastication in the Cognitive Function and Dementia

Cognitive impairment is related to the association of the brain and the stomatognathic system [22]. One of the most seen symptoms in patients with dementia is loss of cognition, thus, the understanding the mechanisms between masticatory function and cognitive impairment are important for the management of dementia [23,24]. Chewing activity and bite force are associated with cognitive function, as mastication is important for neural stimulation in the cerebral cortex [19-26].

In order to have proper levels of learning and memory function in the hippocampus, sensory stimulation from masticatory organs seems necessary in the elderly. Function and morphology of neurons from the hippocampus are also affected by reduced masticatory function [27]. It is possible that stimulation between the right prefrontal cortex and hippocampus is influenced by mastication, thus, helping in the maintenance of cognitive function and memory in the elderly [26]. This may be explained by the fact that peripheral sensory inputs to the hippocampus maintain its function, such as the sensory input from the masticatory system, especially in the elderly [27].

The decrease in bite force and tooth loss have been related to the development of dementia in older people [18,28]. Functions that enhance the levels of mental activity, seem to have a positive result in the synaptic density of the brain, which may be important for the prevention of dementia [17,29]. Masticatory performance is associated with the gray matter volume of the right premotor cortex in older people, while tooth loss is associated with decreased volume of the total brain and cognition impairment in older adults [30,31]. However, it is also referred that the altered ability to chew affects the food intake and nutritional status of the elderly, leading to a possible development of this neurodegenerative disease [12,16]. Another hypothesis proposed is that active chewing reduces the stress and pain in individual, which could also affect the cognitive function [32,33].

The attenuation of masticatory muscle performance and the loss of teeth in older population may reduce the sensory input to the brain, thus, affecting the central nervous system activity [26-34]. Loss of function of posterior teeth due to tooth loss or soft dieting can cause as well occlusal hypofunction that leads to degeneration of the periodontal mechanoreceptors. This reduction of mechanoreceptors could lead to alteration in the sensory feedback from the mouth, possibly affecting the cognitive function in the hippocampus [27-36]. It has also been reported that trigeminal nerve unbalance due to asymmetric muscle performance leads to cognitive impairment, and that restoring the balance of occlusion, thus the trigeminal afferent activity, could improve the cognitive function [37].

Mastication also increases the oxygenation in the hippocampus and prefrontal cortex, by stimulating the cerebral blood flow, which improves the learning activity and memory [26-38]. Considering this, mastication is referred as a way to prevent dementia, AD and stress-related disorders associated with impaired memory and amnesia [27]. Regarding other oral function, about 73-57% of people with dementia present dysphagia [39].

Occlusion of functional natural teeth is also related to preservation of cognitive function in the elderly [11]. Occurrence of mild memory impairment, a high risk factor for dementia, is linked to reduced number of teeth in older people [8,19]. Mild memory impairment might be associated with the presence of periodontal disease and decrease in periodontal mechanoreceptors due to tooth loss [19]. Decreased masticatory performance is also related to a decline in verbal fluency in older patients with dementia [23-40].

Conclusion

It is suggested that attenuation of mastication decreases the cognitive function and cerebral activity, which may increase the risk for development of dementia and AD in the elderly. Proper

evaluation of oral health and function may play an important role in the management of this neurodegenerative disease, so it is necessary further studies in this field.

References

1. National Institute on Aging. Global Health and Aging [Internet]. National Institutes of Health. NIH Publication; 2011; 1-32.
2. Furlaneto IP, Conceição DA, Conceição ML, Lopes ML, Rodrigues YC, Macelino BR, et al. Molecular epidemiology of mycobacteria among herds in Marajó Island, Brazil, reveals strains genetically related and potential zoonotic risk of clinical relevance. *Infect Genet Evol.* 2020; 77.
3. Kalaria RN, Maestre GE, Arizaga R, Friedland RP, Galasko D, Hall K, et al. Alzheimer's disease and vascular dementia in developing countries: prevalence, management, and risk factors. *Lancet Neurol.* 2008; 7: 812-26.
4. Livingston G, Sommerlad A, Orgeta V, Costafreda SG, Huntley J, Ames D, et al. Dementia prevention, intervention, and care. *Lancet.* 2017; 390: 2673-734.
5. Carone M, Asgharian M, Jewell NP. Estimating the Lifetime Risk of Dementia in the Canadian Elderly Population Using Cross-Sectional Cohort Survival Data. *J Am Stat Assoc [Internet].* 2014 ; 109: 24-35.
6. Fernández Z, Martínez M, Castro Flores J, Pérez de las Heras S, Mandaluniz Lekumberri A, Gordejuela Menocal M, et al. Risk factors for dementia in the epidemiological study of Mungualde County (Basque Country-Spain). *BMC Neurol.* 2008; 8: 39.
7. Shin HE, Cho MJ, Amano A, Song KB, Choi YH. Association between mastication-related factors and the prevalence of dementia in Korean elderly women visiting senior centres. *Gerodontology.* 2020; 37: 177-84.
8. Ishikawa T, Ikeda M. Mild cognitive impairment in a population-based epidemiological study. *Psychogeriatrics.* 2007; 7: 104-8.
9. Miura H, Kariyasu M, Yamasaki K, Arai Y, Sumi Y. Relationship between general health status and the change in chewing ability: a longitudinal study of the frail elderly in Japan over a 3-year period. *Gerodontology.* 2005; 22: 200-5.
10. Scherder E, Posthuma W, Bakker T, Vuijk PJ, Lobbezoo F. Functional status of masticatory system, executive function and episodic memory in older persons. *J Oral Rehabil.* 2008; 35: 324-36.
11. Bergdahl M, Habib R, Bergdahl J, Nyberg L, Nilsson LG. Natural teeth and cognitive function in humans. *Scand J Psychol.* 2007; 48: 557-65.
12. Kim JM, Stewart R, Prince M, Kim SW, Yang SJ, Shin IS, et al. Dental health, nutritional status and recent-onset dementia in a Korean community population. *Int J Geriatr Psychiatry [Internet].* 2007; 22: 850-5.
13. Kondo K, Niino M, Shido K. A Case-Control Study of Alzheimer's Disease in Japan - Significance of Life-Styles. *Dement Geriatr Cogn Disord [Internet].* 1994; 5: 314-26.
14. Delwel S, Binnekade TT, Perez RSGM, Hertogh CPM, Scherder EJA, Lobbezoo F. Oral health and orofacial pain in older people with dementia: a systematic review with focus on dental hard tissues. *Clin Oral Investig [Internet].* 2017; 21: 17-32.
15. Ship JA, DeCarli C, Friedland RP, Baum BJ. Diminished submandibular salivary flow in dementia of the Alzheimer Type. *Journals Gerontol.* 1990; 45: 61-6.
16. Sheiham A, Steele J. Does the condition of the mouth and teeth affect the ability to eat certain foods, nutrient and dietary intake and nutritional status amongst older people? *Public Health Nutr.* 2001; 4: 797-803.
17. Gatz M, Mortimer JA, Fratiglioni L, Johansson B, Berg S, Reynolds CA, et al. Potentially modifiable risk factors for dementia in identical twins. *Alzheimer's Dement.* 2006; 2: 110-7.
18. Stein PS, Desrosiers M, Donegan SJ, Yepes JF, Kryscio RJ. Tooth loss, dementia and neuropathology in the Nun Study. *J Am Dent Assoc [Internet].* 2007; 138: 1314-22.
19. Okamoto N, Morikawa M, Okamoto K, Habu N, Hazaki K, Harano A, et al.

- Tooth loss is associated with mild memory impairment in the elderly: The Fujiwara-kyo study. *Brain Res [Internet]*. 2010; 1349: 68-75.
20. Watts A, Crimmins EM, Gatz M. Inflammation as a potential mediator for the association between periodontal disease and Alzheimer's disease. *Neuropsychiatr Dis Treat*. 2008; 4: 865-76.
21. Dominy SS, Lynch C, Ermini F, Benedyk M, Marczyk A, Konradi A, et al. *Porphyromonas gingivalis* in Alzheimer's disease brains: Evidence for disease causation and treatment with small-molecule inhibitors. *Sci Adv [Internet]*. 2019; 5: eaau3333.
22. Lin CS, Lin HH, Wang SJ, Fuh JL. Association between regional brain volume and masticatory performance differed in cognitively impaired and non-impaired older people. *Exp Gerontol [Internet]*. 2020; 137: 110942.
23. Weijenberg RAF, Lobbezoo F, Visscher CM, Scherder EJA. Oral mixing ability and cognition in elderly persons with dementia: A cross-sectional study. *J Oral Rehabil*. 2015; 42: 481-6.
24. Chertkow H, Massoud F, Nasreddine Z, Belleville S, Joannette Y, Bocti C, et al. Diagnosis and treatment of dementia: 3. Mild cognitive impairment and cognitive impairment without dementia. *Can Med Assoc J [Internet]*. 2008; 178: 1273-85.
25. Lexomboon D, Trulsson M, Wårdh I, Parker MG. Chewing ability and tooth loss: Association with cognitive impairment in an elderly population study. *J Am Geriatr Soc*. 2012; 60: 1951-6.
26. Onozuka M, Fujita M, Watanabe K, Hirano Y, Niwa M, Nishiyama K, et al. Age-related changes in brain regional activity during chewing: A functional magnetic resonance imaging study. *J Dent Res*. 2003; 82: 657-60.
27. Ono Y, Yamamoto T, Kubo K ya, Onozuka M. Occlusion and brain function: mastication as a prevention of cognitive dysfunction. *J Oral Rehabil*. 2010; 37: 624-40.
28. Nakata M. Masticatory function and its effects on general health. *Int Dent J*. 1998; 48: 540-8.
29. Orrell M, Sahakian B. Education and dementia. *Bmj*. 1995; 310: 951-952.
30. Lin CS, Wu SY, Wu CY, Ko HW. Gray matter volume and resting-state functional connectivity of the motor cortex-cerebellum network reflect the individual variation in masticatory performance in healthy elderly people. *Front Aging Neurosci*. 2016; 7: 1-9.
31. Dintica CS, Rizzuto D, Marseglia A, Kalpouzou G, Welmer AK, Wårdh I, et al. Tooth loss is associated with accelerated cognitive decline and volumetric brain differences: a population-based study. *Neurobiol Aging [Internet]*. 2018; 67: 23-30.
32. Weijenberg RAF, Lobbezoo F. Chew the Pain Away: Oral Habits to Cope with Pain and Stress and to Stimulate Cognition. *Biomed Res Int [Internet]*. 2015; 2015: 1-7.
33. Weijenberg RAF, Scherder EJA, Lobbezoo F. Mastication for the mind-The relationship between mastication and cognition in ageing and dementia. *Neurosci Biobehav Rev [Internet]*. 2011; 35: 483-97.
34. Okimoto K, Ieiri K, Matsuo K, Terada Y. Ageing and mastication: the relationship between oral status and the progress of dementia at senile hospital. *J Jpn Prosthodont Soc*. 1991; 35: 931-43.
35. Muramoto T, Takano Y, Soma K. Time-related changes in periodontal mechanoreceptors in rat molars after the loss of occlusal stimuli *Archives of Histology and Cytology*. 2000; 63: 369-80.
36. Trulsson M. Sensory-motor function of human periodontal mechanoreceptors. *J Oral Rehabil*. 2006; 33: 262-73.
37. De Cicco V, Barresi M, Fantozzi MPT, Cataldo E, Parisi V, Manzoni D. Oral implant-prostheses: New teeth for a brighter brain. *PLoS One*. 2016; 11: e0148715.
38. Hirano Y, Obata T, Kashikura K, Nonaka H, Tachibana A, Ikehira H, et al. Effects of chewing in working memory processing. *Neurosci Lett*. 2008; 436: 189-92.
39. Alagiakrishnan K, Bhanji RA, Kurian M. Evaluation and management of oropharyngeal dysphagia in different types of dementia: A systematic review. *Arch Gerontol Geriatr [Internet]*. 2013; 56: 1-9.
40. Dintica CS, Marseglia A, Wårdh I, Elgestad PS, Rizzuto D, Shang Y, et al. The relation of poor mastication with cognition and dementia risk: A population-based longitudinal study. *Aging (Albany NY)*. 2020; 12: 8536-48.