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Relationship between the Chewing Ability and Cognitive Function in Elderly: A Systematic Review

Bahruddin Thalib[1], Irfan Dammar[1], Muhammad Ikbal[1], Acing Habibie Mude[1], Irsal Wahyudi Sam[1], Asmawati[2], Al'qarama Mahardhika Thalib[3]

[1]Department of Prosthodontic, Faculty of Dentistry, Hasanuddin University, Makassar, Indonesia.
[2]Department of Oral Biology, Faculty of Dentistry, Hasanuddin University, Makassar, Indonesia.
[3]Department of Dental Material, Faculty of Dentistry, Hasanuddin University, Makassar, Indonesia.
Corresponding Author: bathalib64@yahoo.com

ABSTRACT

The objective was to see the effect of the ability to chew on cognitive function in the elderly. The literature was searched using PubMed and Wiley Online Library (keyword "chewing ability" in subset combined with "cognitive function" and "elderly"). Eighty articles were qualifying as either chewing ability or elderly. Of these, five articles were found in the inclusion criteria, such as cognitive function. Memory loss (cognitive function) is very closely related to physical activity in sports and other activities, including food chewing. Concerning the ability to chew food, the elderly tends to choose foods that are soft or easy to chew. This will impact the reduced activity of the masticatory muscles so that the distribution of blood flow to the brain is reduced.

Keywords: Chewing Ability, Cognitive function, Elderly.

Correspondence:
Bahruddin Thalib
[1]Department of Prosthodontic, Faculty of Dentistry, Hasanuddin University, Makassar, Indonesia.
Corresponding Author: bathalib64@yahoo.com

INTRODUCTION

In the elderly, there is a decrease in the ability of reason and physical due to the aging process. Tooth decay, teeth mobility, caries, halitosis, gingivitis, gingival recession, loss of periodontal attachment, and alveolar bone are changes in periodontal tissue that are commonly found in the elderly. If these are not treated properly can cause mobility and tooth loss, which will interfere with the function and activity of the oral cavity, especially disruption in the mastication process.[1,2]

The main factor in the disruption of the mastication process is tooth loss which is a cumulative process that cannot be recovered, which is no longer considered a natural consequence of aging.[2] Tooth lost has implications for the loss of some orofacial parts, like bone, nerve, receptor, and muscle tissue. As a result, most of the orofacial function is decreased. Studies showed that reducing the number of teeth affects the ability to chew so that nutrient intake will be less and will affect overall general health.[3,4]

The mastication process has been shown to improve cognitive function of the brain and maintain general health[5,6] The mastication process can increase the blood's oxygen levels in the brain structure such as in the prefrontal cortex and hippocampus, which are playing important role in learning and memory. Data shows that there is a simple way to prevent dementia and stress-related disorder often associated with cognitive impairment such as spatial memory disorders and amnesia such mastication. Chewing stimulation can maintain that cognitive function is also clear from epidemiological studies that show the number of remaining teeth or tooth loss, the use of dentures, and the small maximum bite strength are related to the development of dementia.[6.]

Tooth loss in the elderly can cause masticatory disorders, temporomandibular joints (TMJ), psychological function, and speech. When a tooth is lost, its interior sensory receptors are also lost. Changes or damage to the teeth' sensory functions can cause sweeping changes in indigestion and associated functions such as postural balance control. When some tooth loss occurs, cortical sensory and motor maps, re-rewiring, and rebuilding nerve pathways at various levels make it arduous to return to the original optimal and optimal neuromuscular connections and the associated cross-modal multisensory functions. Furthermore, continuous cortical rewiring and rebuilding of nerve pathways can result in non-ideal or excessive connections, thereby losing the high level of efficacy of the original function. It was hypothesized that long-term use of these non-ideal connections would likely accumulate in abnormal load levels, produce excessive Beta-Amyloid production, and cause synaptic and extrasynaptic dysfunction and burden the brain neuroplasticity limits. Under certain circumstances, all of these conditions can combine to form short circuits and become the last in solving the healthy functioning brain that survives.

METHODS

The articles were searched using the PubMed database to create a study protocol. Questions PICO define search strategies, which are P = elderly, I = using prosthesis, C = tooth loss, O = level of dementia. These were searched using MeSH (Medical Subject Headings). The keywords were "dementia" and "tooth loss" and "denture" and "elderly." Eighty journals are describing this method; 5 articles were found in the inclusion criteria.

Eligibility criteria

The following criteria were rated for selected studies:

- English article
- Absence of tooth loss
- Journal of dementia
- The study reports of mastication in the elderly
- The journal of the use of dentures

Exclusion criteria are all journals that do not meet the criteria mentioned above, such as animal studies, treatment with complications not included in this study. After reading the full text of the article, the data was evaluated with the predetermined exclusion criteria. The

eligibility criteria are used to identify articles that will be used for this systematic review.

Data processing

Data were reviewed by two reviewers (AA and BT) regarding the following parameters: dementia, using dentures, tooth loss, and the elderly. Full texts that meet the inclusion criteria were reviewed independently and evaluated to formulate this systematic review.

RESULTS

The database identified 72 articles from PubMed and eight articles from Wiley. The title and abstract were reviewed afterward, and 19 studies were eligible for further analysis. After eliminating the articles among the databases by reviewers and five articles were found in the inclusion criteria. The description of included records in the systematic review is shown in Figure 1, with a total of 5 selected from the initial 80 results studied by the electronic literature search. After 19 full-text titles were reviewed, five articles were selected for inclusion in this systematic review, of which 75 other items were excluded for several reasons.

The result from reviewed literature indicated that Komiyama et al. and Takeuchi et al., subjects in the total edentulous group showed that the highest percentage of dementia patients was 12.4% in the Komiyama et al. study and 47.1% in the Takeuchi study et al. Meanwhile, Furuta et al. concluded that the highest percentage of dementia patients was 77.1% in groups of ten to nineteen. The lowest rate of dementia patients, all studies found that it was in the group of remaining teeth ≥20, namely 61% in the Furuta et al. study, 6.4% in the Komiyama et al. study, and 14% in the Takeuchi et al. study.

DISCUSSION

This systematic review showed a complex path between cognitive abilities and oral health. Having fewer teeth causes the using of dentures, but severe cognitive impairment interferes with the use of dentures because the problems of dental care; dysphagia or difficulty chewing caused by fewer teeth; it could damages the ability of elderly people to consume food in sufficient quantities and leads to malnutrition. Malnutrition and cognitive impairment are associated with poor muscle strength and decreased physical performance, which can lead to disability and reduce the ability to perform activities required of daily life.

Furthermore, mastication also has a relation in cerebral blood flow. Studies show that mastication increases the velocity of blood flow in the middle cerebral arteries. Having proper chewing function can restore cognition after cerebrovascular damage and get prosthodontic treatment because tooth loss can improve brain perfusion, associated with better perception. The mastication process is crucial for peripheral sensory input to the hippocampus, an area of the central nervous system that is important for spatial memory and learning, aiming to maintain cognitive function. The systemic effect of masticatory dysfunction is a risk factor for dementia. Blood oxygen levels in the frontal cortex and hippocampus increase due to mastication, which may be necessary for learning and memory.[7]

Sensory information is transmitted through the trigeminal afferent nerves to the trigeminal sensory core, cerebellum, hypoglossal motor nucleus, to the formation of the reticular brainstem. The formation of the reticular and the activating system of the developing reticula is needed to generate brain function, which results in attention, perception, and awareness of learning. Neurons from the trigeminal sensory nucleus reach the posterior ventral nucleus of the thalamus, reticular formations, and the hypothalamus. Therefore, the hippocampus through the thalamus and cerebral cortex can be affected by sensory information from the masticatory organs..[4]

Histologically, decreased masticatory function can impair cognitive function, selective attention function and memory function in the cerebral cortex. Chewing dysfunction also causes morphological changes in the hippocampus and cerebral cortex; For example, the condition of molar loss can decrease brain cells, including synapses in the hippocampus and parietal cortex and expression of neurotrophic receptors in the hippocampus. This is also supported by the results of neuroimaging clinical trials using functional MRI and positron emission tomography showing that several brain regions are activated during mastication, including the cortex, thalamus, striatum, and cerebellum. The results of a functional MRI evaluation of neuronal activity in the brain showed that chewing activity increased signaling depending on blood oxygen levels in the right premotor cortex, precuneus, thalamus, hippocampus, and inferior parietal lobe..[8]

Cerebral blood flow (CBF) decreases with age, and the brain atrophy index increases when regional CBF decreases. Positive correlations have been observed in a number of elderly people and have carotid artery blood flow and intellectual and mental function. The autonomic nervous system response caused during the chewing process increases metabolic activity and stimulates the oral tissues, resulting in increased blood flow not only to the oral tissues but also to the brain. The increase in regional CBF at the time of the mastication process may allow sensory information to be sent to the brain via the neural input subsystem of the effector subsystem of the masticatory system. There is an increase in the partial pressure of carbon dioxide resulting from an increase in the metabolic activity of the cortical sensorimotor neurons in feedback, which arises as a result of widening of the capillary lumen. A recent study evaluated the differences in CBF between toothless subjects and those with implant prostheses. CBF increased significantly with subjects using implanted prostheses.[1]

Based on a study conducted by Bahruddin et al., the elderly with dentures have better nutritional status (68.8%) and cognitive function well instead of elderly who did not wear dentures (53.1%).[9] There are several possible pathways by which the number of remaining teeth may be related to the onset of functional defects. Several prospective studies have examined the relationship between tooth loss and the risk of all causes of dementia. A prospective cohort study in elderly Japanese adults shows that subjects with some teeth left without dentures have an incidence of dementia. Similarly, in the elderly cohort with type 2 diabetes mellitus, tooth loss appears to be significantly associated

with a higher risk of the incidence of all causes of dementia.

CONCLUSION

Based on the recent studies, the amount of tooth loss affects dementia's cognitive level of dementia. This report shows that there is a direct comparison between tooth loss and cognitive impairment or dementia. The higher the amount of tooth loss, the higher the risk of a patient suffering from cognitive impairment and can even cause dementia. Further research is needed with more specific cognitive impairment levels and more information about using dentures to deduce better and more accurate results.

Several studies show tooth loss can be a risk factor for dementia, and the risk of dementia also increases with the increasing Tooth loss. Where tooth loss is in harmony with decreased mastication, which plays an essential role in maintaining cognitive function in the hippocampus and also chewing, is a practical approach in supporting learning and memory-related to the hippocampus in the elderly. Appropriate prosthodontic treatment can reduce the risk of dementia associated with tooth loss. Nevertheless, it remains to be determined whether the use of removable dentures is safe for patients losing teeth with dementia.

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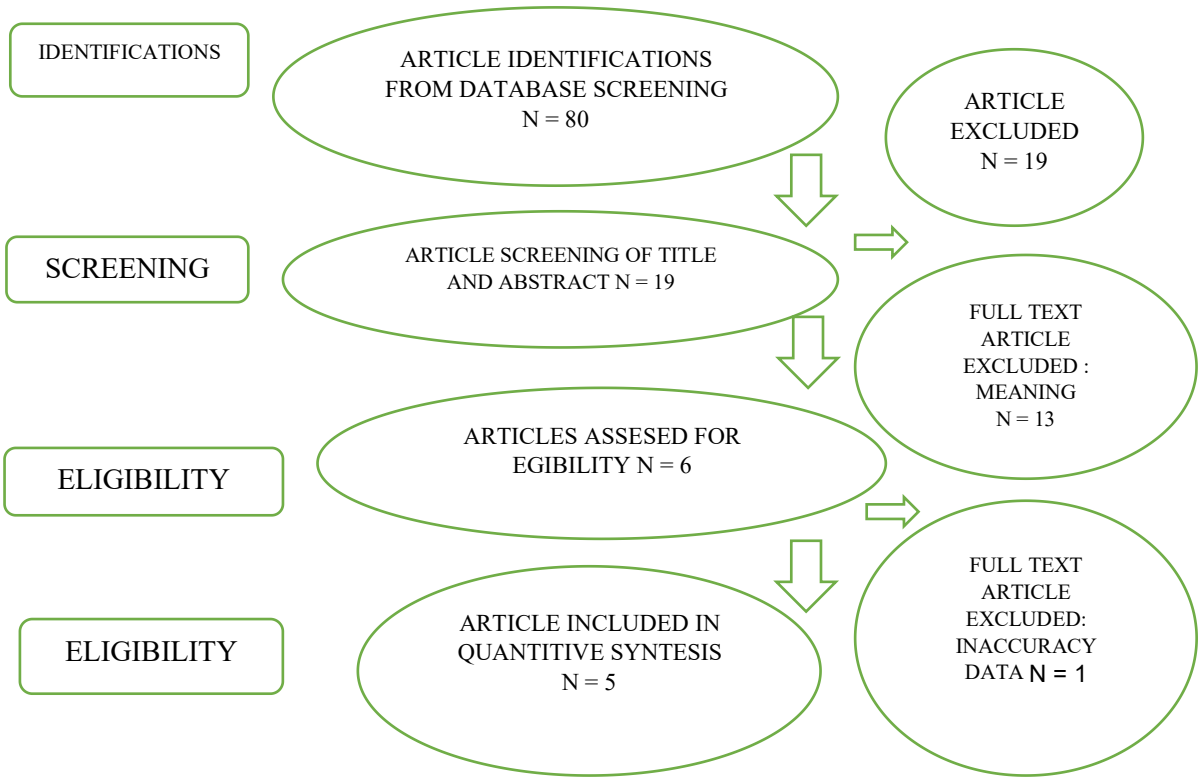

Figure 1. Description of included records in the systematic review

Table 1. Result of articles that met inclusion criteria

Author (Year)	Subject	Country	Study design	Age	Remain Tooth	Dementia/ Cognitive impairment	Total of dementia (%)
Xi Chen et al. (2012)	902	USA	Prospective study	≥ 60	≥ 24	21.5	23.4
					17 – 24	38.3	34.5
					9 – 16	28.0	23.7
					1 – 8	12.1	18.4
Furuta M, et al. (2012)	286	Japan	Prospective study	≥ 80	≥ 20	61.0	39.0
					10-19	77.1	22.9
					0-9	73.2	26.8
Komiyama et al. (2016)	834	Japan	Prospective study	≥ 70	≥ 20	6.4	93.6
					10-19	10.3	89.7
					1-9	11.0	89.0
					0	12.4	87.6
Takeuchi et al. (2017)	1566	Japan	Prospective study	≥ 70	≥ 20	14.0	86.0
					10-19	28.8	71.2
					1-9	33.3	66.7
					0	47.1	52.9
Zahra S, et al. (2017)	50	UEA	Prospective Study	≥ 60	22 – 32	64.7	35.3
					11 – 21	45.5	54.5
					0 – 10	13.6	86.4