REVIEW ARTICLE

Masticatory Ability in People With Alzheimer's Disease: a Scoping Review

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ABSTRACT

People with Alzheimer's Disease exhibit decreased cognitive function and lower sensory and motor sensitivity that lead to decrease functional abilities. Alzheimer's Disease affects brain areas related to mastication. There is limited evidence regarding how masticatory ability is obeserved and assessed in people with Alzheimer's Disease.This review assessed overview parameters of masticatory ability in people with Alzheimer's Disease based on various online database sources. This study used a scoping review technique. Article searches were conducted through PubMed, Cochrane, CINAHL databases and other relevant publications through the references of selected articles (snowballing technique). There was a poor masticatory ability in people with Alzheimer's Disease. People with Alzheimer's Disease had a reduced number of teeth and functional tooth units or paired occlusion which can cause low bite force which results in difficulty chewing hard food. The use of prostheses can only increase the efficiency of mastication without removing the disturbance. The parameters that most widely used for masticatory ability assessment were based on commonly method (Mandibular Movement (MM), sieving method with optocal cubes, chewing gum, bite force, occlusion force, occlusal contact area and mandible assessment.) and teeth condition (number of teeth present, number of missing teeth, periodontal status, caries and dental filling, number of Functional Toth Units (FTU), Functional masticatory Unit (FMU), and bite force. Assessment of masticatory ability with appropriate parameters is one of the efforts to explore the possibility of delaying the progressive decline in cognitive function that occurs in AD dementia.
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Keywords: Alzheimer's disease, Cognition, Dementia; Mastication, Masticatory forcehism, Dental

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INTRODUCTION

Alzheimer's Disease (AD) is an early sign of decreased cognitive and functional abilities that affect the quality of life (QoL). The quality of life of people with AD can be seen from individual's ability to perform daily activities. Most individuals with AD need family assistance or a care giver in carrying out activities.[1,2] Generally, people with AD, experience an emotional change, insomnia, confusion, aggression, long-term memory loss and balance disorders, which will gradually lead to loss of body function.[1]

The World Alzheimer's Report in 2015 showed that Asia had the highest number of people with dementia at around 22.9 million, compared to Europe at around 10.5 million and America at around 9.4 million. Data from Alzheimer's Disease International revealed that in 2015 the Indonesian population with dementia was one million. It was estimated increased to 2 million people in 2030, and 4 million people in 2050 progressively.[3] The incidence of AD increased significantly with age. It was found higher in women than in men.[4,5] The prevalence of AD in people aged 65-74 years was 3%, aged 75-84 years was 17% and aged over 85 years was 32%.[6] With increasing the life expectancy, it is estimated that the number of people with AD will continue to increase.[7-9]

A study by Shin et al[10] and Kimura et al[11] reported that low masticatory ability was associated with lower

cognitive function. Meanwhile, Onozuka et al explained that masticatory activity increased the blood flow in the prefrontal cortex and hippocampus associated with learning and memory processes, and increased blood oxygen levels in the sensorimotor cortex, supplementary motor areas, insular cortex, thalamus, and cerebellum. [12-14] The previous area is related to masticatory system.

Masticatory ability is influenced by several factors, including tooth loss, lack of wearing dentures and decreased maximum occlusal force (bite force). Tooth loss is the greatest risk factor for decreased masticatory ability, and generally occurs in elderly.[15,16] This decline in oral function due to number of remaining teeth was a significant risk factor for cognitive impairment based on the evaluation of MMSE (Mini Mental State Examination) in elderly ≧65 years.[17] Moreover, a study showed that patients with mild AD had lower score of mastication and score of MMSE compared to the control group.[18]

Several studies have been conducted to assess and describe the relationship between chewing ability and AD using various parameters. [3,10-12] As well as studies addressing factors affecting chewing ability in AD. [13-15] Meanwhile masticatory function in term of masticatory ability can be assessed using objective and subjective test. Subjective test can not be standardised between participants and do not spesifically measure the mechanics of chewing process instead. Therefore, this scoping review will focus on objective parameters of masticatory ability assessment in people with AD. The results of this scoping review are expected to be a benchmark for further research to assess ability of masticate using appropriate parameters and it becomes one of the efforts to explore strengthening in the aspect of masticatory performance, comprehensively.

Objective

This study aimed to overview parameters of the masticatory abilities in people with AD based on literatures review.

METHODS

This study is Scoping Review which aims to mapping, summarize and identify study gaps from the existing literature by using the Preferred Reporting Items for Systematic Review and Meta-Analyses for Scoping Review (PRISMA- ScR), and guidelines from the Joanna Briggs Institute (JBI). This study used the criteria of Population, Concept, Context (PCC) in people with Alzheimer's Disease (P), mastication ability (C), with original study and review articles (C). A search of PubMed, Cochrane, and CINAHL databases was performed to identify the studies. These databases were searched from January 2021- May 2021 with the keywords masticatory dysfunction, masticatory decline, masticatory performance, masticatory ability, masticatory efficiency, Alzheimer's Disease, and dementia. In addition, other relevant publications were found by going through the references of some selected articles.

Empirical and review articles that examine masticatory abilities in people with Alzheimer's disease, articles in English and studies conducted on humans were included. Articles in the form of case reports, case series, debates and articles that cannot be accessed for full paper were excluded. This study has no restrictions on the year of publication.

A data extraction from was completed for each of the included articles. The following information was retrieved from the articles: Title and authors, year published, sample studied, study location, study type, parameters and instruments used to assess masticatory ability and cognition functions, and outcome measures. The extracted data analyzed with the principle of thematic analysis. Data were presented in a structured and systematic tabular form, then structurally and systematically arranged into a discussion.

RESULT AND DISCUSSION

A total of 90 articles, in which 50 articles on PubMed, 34 articles on CINAHL and 6 articles on Cochrane. Screening were conducted three times as shown in Figure 1. The final screening was conducted by reading the entire contents of the article and 23 articles were obtained to be analyzed, consisting of 17 empirical articles and 6 review articles. This study included 3 articles obtained through the snowballing technique. A total of 26 articles were analyzed.

From the articles reviewed, cognitive impairment group had fewer teeth or more tooth loss [19-26], lower the number of Functional Tooth Units (FTU)[27] and Functional Masticatory Unit (FMU) value, [28] than the control group. However, there was no significant difference of score MMSE between groups using upper

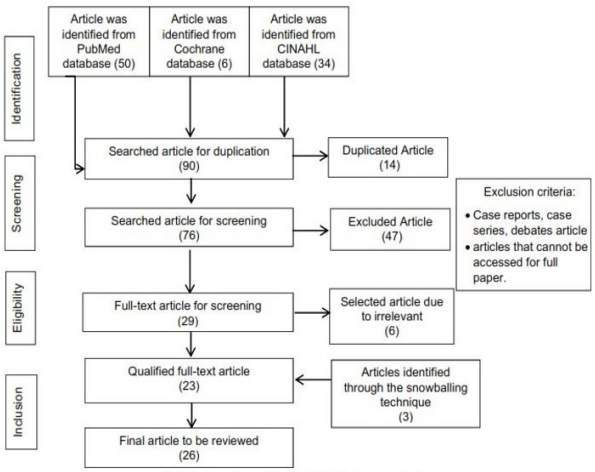

Fig 1 Search result of PRISMA-ScR analysis

jaw prostheses and without upper jaw prostheses in mild cognitive impairment.[29] Other parameter for assessing masticatory ability were bite force, paired occlusion, and contact occlusion that showed lower in impaired cognition.[16,20,21,30] One article found that people with AD showed a higher Mandibular Movement (MM) values measured by Jaw Tracking Kinesiographic device[20] and one article found a lower ability to open the mouth in participants with impaired cognition.[30] One article showed that there was impaired mastication efficiency in the AD group compared to the control group before and after the use of prostheses, respectively.[31] Two article found that individuals with dementia had difficulty chewing hard food.[24,32] The results can be shown in Table I.

Table I. study results

Author(-year)	Title	Sample	Location	Study design	Parameter and Instruments		Result
					Cognition	Mastication	
Nordenram et al[23] (1996)	Alzheimer's disease, oral function, and nutritional status	N= 40 participants with ADlive in a nursing home N= 40 participants in the control group living independently	Sweden	Comparative study	DSM III-R	Eichner index	In the AD group, more participants were edentulous and did not use dentures
Miura et al[21] (2003)	Relationship between cognitive function and mastication in elderly females	N=44 female participants with normal cognitive abilities N=44 female participants with cognitive impairment	Japan	Epidemiological approach	HDS-R	Number of teeth present, bite force, occlusal contact	Number of teeth present, bite force, and occlusal contact were significantly lower in the group with cognitive impairment
Okamoto et al[26] (2010)	Tooth loss is associated with mild memory impairment in the elderly : The fujiwara-kyo study	N= 3061 participants aged 65 years or older with MMSE score ≥ 24	Japan	Cross-sectional	MMSE	Dental condition, periodontal status	Tooth loss correlated with MMI (mild memory impairment) later in life
Ono et al[33] (2010)	Occlusion and brain function : mastication as a preventive cognitive dysfunction	N.A	Japan	Review	N.A	N.A	Masticatory activity could regulate prefrontal cortex and hippocampus to improve cognitive function.
Weijenberg et al[16] (2011)	Mastication for the mind: the relationship between mastication and cognition in ageing and dementia	N.A	Netherland	Review	N.A	Bite force, jaw muscles, maximal mandibular excursion, number of teeth	Elderly with impaired cognitionshow a low value of bite force, few occlusal contacts and a small number of teeth
Lexomboon et al[24] (2012)	Chewing ability and tooth loss: association with cognitive impairment in an elderly population study	N= 557 individuals aged 77 years or older	Sweden	Cross-sectional	MMSE	Dental condition, information on chewing ability (self report)	Loss of multiple teeth and difficulty in chewing hard foods were significantly correlated with impaired cognition
Kimura et al[11] (2013)	Evaluation of chewing ability and it's relationship with activities of daily living, depression, cognitive status and food intake in the community-dwelling elderly	N= 269 elderly (88 males and 181 females) aged 75 years or older	Japan	Cross-sectional	MMSE, HDS-R ann FAB	Color changing gum, questionnaire for difficulty chewing hard food	Significant correlation between low mastication ability and low cognitive score

CONTINUE

Table I. Study results (cont.)

Author (year)	Title	Sample	Location	Study design	Parameter and Instruments		Result
					Cognition	Mastication	
Elsig et al[34] (2013)	Toothloss, chewingefficiency and cognitive impairment in geriatric patients	N= 7 males and 22 females in the dementia group N= 5 males and 17 females in the normal group	Swiss	Cross-sectional	MMSE, CERAD	Chewing gum, number of teeth present, prosthodontic status	-The difference in number of teeth in dementia group and control group was not significant -Significantly better masticatory efficiency in control than cognitive impairment
Nilsson et al[25] (2014)	Tooth loss and cognitive functions among older adults	N= 1147 individuals aged 60-96 years	Sweden	Cross-sectional	MMSE and clock test	Number of teeth present	The risk of a low cognitive assessment score correlated with number of teeth
Teixeira et al[35] (2014)	Masticatory Deficiency as a Risk Factor for Cognitive Dysfunction	N.A	Brazil	Review	N.A	N.A	Mastication plays a role in cognitive function, and masticatory disorders may be a risk factor for dementia
Weijenberg et al[19] (2015)	Oral mixing ability and cognition in elderly persons with dementia: A cross sectional study	N= 114 elderly with dementia receiving psychogeriatric care	Amsterdam	Cross-sectional	MMSE, neuropsychological test	Chewing gum (pink and blue)	General cognition and verbal fluency were positively correlated with mastication performance in elderly with dementia
Campos et al[18] (2016)	Correlation of cognitive and masticatory function in Alzheimer's disease	N=16 elderly (removable prosthesis with mild AD) N=16 elderly (removable prostheses without AD) Each participant experienced total/ partial tooth loss	Brazil	Cross-sectional	MMSE	Eichner index, Sieving method with optocal cubes	There was a moderate correlation indicating impaired cognition and mastication in individuals with mild AD
Campos et al[20] (2016)	Mandibular movements and bite force in Alzheimer's disease before and after new insertion	N= 16 participants with mild AD (mean age 77 years) N=16 control group (mean age 76 years) Each group consisted of 11 individuals with complete tooth loss and 5 individuals with partial tooth loss	Brazil	Cohort prospective	MMSE, CDR, DSM-IV	Maximum Bite force (MBF),- Mandibular Movement (MM)	-People with AD had lower MBF scores than the control group -The MM value in individuals with AD showed a higher value
Campos et al[31] (2017)	Mastication and Oral Health Related Quality of Life in Removable Denture Wearers with Alzheimer's Disease	N=16 elderly (removable prostheses with mild AD) N=16 elderly (removable prostheses without AD) Each participant experienced total/ partial tooth loss	Brazil	Non randomized control trial	MMSE, CDR,DSM- IV	Sieving method with optocal cubes	There was impaired mastication efficiency in the AD group compared to the control group both before and after the use of prostheses
Kim et al[36] (2017)	Relationship between chewing ability and cognitive impairment in the rural elderly	N= 295 elderly participants aged over 70 years from rural areas of Korea	Korea	Cross-sectional	MMSE-DS	Color changing gum	The mean chewing ability was significantly lower in the group with cognitive impairment than the normal group or the group at risk of cognitive impairment

CONTINUE

Table I. Study results (cont.)

Author (year)	Title	Sample	Location	Study design	Parameter and Instruments		Result
					Cognition	Mastication	
Tada et al[37] (2017)	Association between mastication and cognitive status: a systematic review	N= 22 cross-sectional article N= 11 cohort articles	Japan	Systematic Review	MMSE, HDS-R, FAB, episodic memory, executive function, clock test, MOCA, neuropyschological test, DWR, WF, DST, BDT, DSS, SDST, SDLT	Number of teeth, prosthesis, color changing gum, dental status, mandible, bite force	-Cross sectional study showed poor mastication ability correlated with low cognitive function and dementia -Prospective cohort study showed poor masticatory ability is a risk factor for decreased cognitive function and the incidence of dementia
Delwel et al[30] (2018)	Oral function of older people with mild cognitive impairment or dementia	Participants with MCI or dementia aged 60 years or older	Netherland	Cross-sectional	MMSE	Occlusion partner, tooth wear, prosthesis, mandible	-Participants with significantly worse cognitive impairment had fewer pairs of occlusions and smaller mouth opening abilities. -The degree of tooth wear is less than 1/3 of the clinical crown in participants with MCI and dementia
Cardoso et al[28] (2018)	Relationship between functional masticatory units and cognitive impairment in elderly persons	N= 502 white participants (389 women and 113 men) aged 65-102 years	Portugal and Spain	Cross-sectional	MCE	Functional masticatory units	FMU was significantly correlated with MCE score, the higher the FMU number, the lower the possibility of cognitive impairment
Weijenberg et al32 (2018)	Mind your teeth: The relationship between mastication and cognition	N.A	Netherland	Review	N.A	N.A	People with dementia had difficulty chewing solid food. The number of teeth did not significantly affect cognitive function
Shin et al[10] (2019)	Association between mastication related factors and the prevalence of dementia in Korean elderly women visiting senior centres	N= 101 participants aged 65 years or over	Korea	Cross-sectional	MMSE-DS	Occlusion force, color changing gum, chewing 5 kinds of food Color changing gum,	-There is a correlation between masticatory ability and cognitive function -Positive correlation between cognitive function and posterior occlusion force
Delwel et al[29] (2020)	Chewing efficiency, global cognitive functioning and dentition: A cross sectional observational study in older people with mild cognitive impairment or mild to moderate dementia	N= 136 participants aged 60 years or older with MCI or dementia	Amsterdam	Cross-sectional	MMSE	number of teeth present, occlusion partner	-The MMSE score was not significant between upper jaw protheses and without upper jaw protheses group -Global function of cognition was not associated with mastication in the elderly with MCI or mild or moderate dementia after adjusting for age and teeth.
Lin et al[38] (2020)	Association between regional brain volume and masticatory performance differed in cognitively impaired and non impaired older people	N= 31 participants with cognitive impairment N= 31 participants without cognitive impairment	Taipei	Cohort	MMSE	Color changing gum, the number of missing teeth	The group with cognitive impairment showed lower mastication performance compared to the non-CI group

CONTINUE

Table I. Study results (cont.)

Author (year)	Title	Sample	Location	Study design	Parameter and Instruments		Result
					Cognition	Mastication	
Lin et al[27] (2020)	Association between tooth loss and gray matter volume in cognitive impairment	N= 40 participants (19 people with MCI and 21 people with AD) N=30 control group	Taipei	Cross-sectional	MMSE, CASI	The number of missing teeth, prostheses, color changing gum, Functional Tooth Unit (FTU), Eichner index	The group with cognitive impairment showed significantly lower mastication performance, FTU and MMSE scores, but higher number of tooth loss.
Egashira et al[22] (2020)	Low tongue strength and the number of teeth present are associated with cognitive decline in older japanese dental outpatients: A cross sectional study	N= 58 outpatient participants who regularly received dental care from a dentist	Japan	Cross-sectional	MoCA-J	The number of teeth present, the Eichner index, color changing gum	-Mastication performance was significantly lower in the group with cognitive impairment than the control group -The number of teeth present was less in group of cognitive impairments
Dintica et al[39] (2020)	The relation of poor mastication with cognition and dementia risk: a population based longitudinal study	N= 544 participants aged over 50 years who had been followed for 22 years	Sweden	Longitudinal study	PCA	Teeth condition, Eichner index	Poor masticatory ability correlates with acceleration of cognitive impairment
Chaichio et al[40] (2020)	Oral health and healthy chewing for healthy cognitive ageing : A comprehensive narrative review	N.A	Spain	Review	N.A	N.A	Changes in mastication or occlusion had impaired cognition by decreasing the activity of brain areas

Masticatory Ability and Cognitive Impairment

Masticatory ability is lower in patients with cognitive impairment. Most of study found that the group with cognitive impairment tended to have low masticatory performance.[10,11,18,19,22,24–29,34,36] People with cognitive impairment showed fewer teeth compare to control group.[21–28] However, in a study conducted by Delwel et al was found that global cognition was not associated with mastication in the elderly with MCI and dementia due to no significant differences in groups with upper jaw protheses and groups without upper jaw protheses.[29]

In cohort study, cognitive impairment showed a lower masticatory ability and increase the incidence of dementia [20,38]. Masticatory ability was significantly correlated to dementia incidence [34] and masticatory ability was significantly better in control groups.[25] In a longitudinal study, poor masticatory ability was also found correlated with cognitive impairment progress. [39] People with AD had masticatory decline either prior to or after the use of a prosthesis in a non-randomized control trial. Oral rehabilitation with prostheses can improve masticatory efficiency but cannot completely eliminate chewing disorder in people with AD.[31] Masticatory activity in individuals with AD was impaired compared to the elderly without dementia who have similar oral characteristics. This shows the adverse impact of AD on masticatory ability.[18]

Methods in assessing parameters of masticatory function

In assessing masticatory function, researchers also use various methods such as sieving method with optocal cubes,[18,31] chewing gum,[10,11,19,22,27,29,34,36, 38] bite force.[20, 21, 37] occlusion force[10], occlusal contact area[21], mandible assesment that assessing overbite, active and passive mouth opening, and MM which measured the chewing movements.[20,30] Several researches only evaluate teeth condition such as number of teeth present,[22,24,25,29,34,39] number of missing teeth,[24,27,38,39] and other general conditions such as periodontal status,[41] caries or dental filling[26] without paying attention to functional masticatory ability. Masticatory ability can also be seen from the assessment based on prosthodontic status and

the use of prostheses,[27,30,34] number of FMU[7,28], toothwear,[30] participants ability to chew five types of food,[10] self-assessment,[24] and questionnaire regarding the participants ability to chew solid food.[11] Selection of measurement methods is selected based on the aims of the study, availability of tools, and duration, without being explicitly mentioned in each article.

Most widely used parameter for cognitive function

Among the parameters for cognitive function, MMSE is one of the most widely used. MMSE has a good validity, sensitivity and specificity, simple scoring technique, and can be accepted as a diagnostic instrument for health researchers. However, MMSE lacks in detecting early signs of dementia. The MMSE was found to be sensitive to age and education level, so the MMSE result can be false positive when education level is not considered. The use of MMSE can be combined with other assessment parameters to get more accurate results.[42,43,44]

The other parameter is MOCA. Moca is one of measurement recently used. MOCA was found to have a higher sensitivity to mild cognitive diseases compared to MMSE and may predict cognitive disease with high accuracy[45,46].

Factors influencing mastication function

The ability of mastication is affected by various factors, such as condition of the teeth, the number of remaining antagonist teeth, chewing surface area, bite force, prostheses, masticatory movements, food consistency, and distribution of the bolus during mastication. Masticatory ability is also defined as an individual's assessment of his masticatory function.[47,48,49]

Assessment of masticatory ability can be done subjectively and objectively. Assessment of subjective mastication ability can be done using a questionnaire related to food preferences or patient chewing satisfaction. "Do you feel discomfort when chewing?" is a questionnaire for assessment by providing a questionnaire regarding the participants difficulties in chewing solid food.[11] Objective masticatory ability is measured by determining the individual's ability to grind and crush the test food in a predetermined cycle. One of the objective assessments can use the sieving method to measure the weight of the chewed food by filtering. In this procedure, optical cubes were given to each participant and chewed in 40 masticatory cycles, the chewed particles were then collected on a filter paper and dried, after which the particles were vibrated using a sieving machine. The principle of this method is that with an effective mastication process, the greater the proportion of food that will pass through the filter holes.[18,31,47,48]

The latest study was conducted using chewing gum, participants were asked to chew gum that can change color, then mastication ability was assessed based on the intensity of the color produced from the chewing gu m,[10,11,19,22,27,29,34,36,38] but examination using gum is difficult without using a digital tools, and chewing gum is sometimes attached to the prosthesis used by the elderly during the assessment.[11,29] However, chewing gum use is more convenient in elderly because it is more simple and practical.[50] For the next studies, the mastication assessment tools needs to be developed especially for vulnerable people.

Other assessments is bite force using Bite Force Transducer[20] and another article using Prescale system.[21] One of the other parameters found to be low in individuals with AD is bite force. This caused by skeletal muscle atrophy, decreased strength, and physical weakness in individuals with AD, causing disturbances in the bite force.[18,20]

Variables in influencing masticatory function

Assessment using the Eichner index was also carried out in several studies. The Eichner index divides teeth a total of four zones of occlusal support. Based on this index, the occlusal contacts of the posterior teeth i.e. premolars and molars were calculated as one area. The Eichner index is divided into three categories, namely category A (having four posterior occlusal contacts), category B (having 1-3 posterior occlusal contacts) and category C (no posterior occlusal contacts).[18,22,23,27,39]

Examination of the remaining teeth and missing teeth is one of the examinations that is often used because it is quite easy to do in elderly. Most studies found that people with impaired cognitive function had a low number of teeth.[22,24,25,29,39] Tooth loss lead to loss of sensory function of the periodontal ligament, reduced muscle activity of mastication and affected brain activity. [51] The disadvantage is the number of teeth sometimes cannot determine the objective ability of mastication. However, studies by Elsig et al[34] and Weijenberg et al[32] stated that the number of teeth had no significant effect on cognitive function.

Mechanism behind mastication function and cognitive function

The ability of mastication is an important stomatognathic function that can affect the quality of life. [52] Mastication is a vital orofacial function that regulated by Central Pattern Generator (CPG) in brain stem. Most of the muscles of mastication are innervated by the motor branch of the fifth cranial nerve, and the process of mastication is controlled by nuclei in the brainstem. Mandibular movement requires input from various sensory receptors and must be received by the central nervous system via afferent nerves. The brain receives sensory information from several mechanoreceptors in and around the mouth, regulating jaw movement through sensorimotor regulation, encoding masticatory force and regulation of food, biting and chewing. The brain stem also contains other components such as the

reticular, limbic, and hypothalamic systems, where these components can affect masticatory function. [20,53,55] Masticatory activity can increase cerebral blood flow in sensorimotor cortex area, supplemental motor area, insular cortex, corpus striatum, thalamus and cerebellum, which causes chewing activity to improve memory and attention.[11,19,28,33,36,56] The prefrontal cortex is more active when masticatory activity takes place. [57] Individuals with mastication disorder was a risk factor for the development of dementia caused reducing cerebral blood flow and brain activity. Decreased cerebral blood flow can affect brain circuitry, neurotransmission system and neurogenesis activity that can lead to impaired cognition and vice verse. [31,34,36] People with AD showed reducing masticatory muscle function, loss of appetite and impaired masticatory function. In addition, more active mastication with more chewing cycle can be influence by smell, taste, texture and hardness of food. Neuronal damage and brain atrophy in AD affected areas associated with mastication and the corticobulbar tract for masticatory function.[18]

Chewing gum can improve working memory and long-term episodic memory, increase attention and speed in processing something.[16] and the other way attention scores were higher in people who chewed gum.[19] Chewing gum both unilaterally and bilaterally produced activity in several brain areas, including right prefrontal cortex, left insular, thalamus, anterior bilateral cerebral hemispheres, vermis, supplementary motor areas (SMA), medial singular gyrus, primary motor, premotor cortices, bilateral primary and secondary cortices in which play a role in cognitive function.[40] Chewing gum also improved the performance of cognitive tasks when the gum was chewed for 5 minutes before, and this benefit lasted for the first 15-20 minutes of the test.[58]

CONCLUSION

Parameter to assess masticaoty ability based on the commonly method were Mandibular Movement (MM), sieving method with optocal cubes, chewing gum, bite force, occlusion force, occlusal contact area and mandible assessment. Meanwhile parameters based on teeth condition were number of teeth present, number of missing teeth, periodontal status, caries and dental filling, number of Functional Tooth Units (FTU), Functional masticatory Unit (FMU), and bite force. In addition, this scoping revealed that chewing gum method was the most commonly used and possibly the easiest method to implement in clinical setting.

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