

Impact of Using Denture on Cognitive Function in the Elderly

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Abstract

The Aim of this study is to investigate whether using denture can improve cognitive function on the elderly. This study is a clinical trial with 40 subjects, elderly aged ≥ 60 years, missing more than 10 teeth with loss of occlusion at the time of the study. Thirty subjects undergone denture treatment and were given dentures. The other subjects were the control group, who underwent pre-prosthetic treatments, but weren't given dentures until after the study has ended. All subjects in the denture group completed a series of cognitive tests using HVL, MMSE and Verbal Fluency test at baseline and at follow-up sessions 1 and 2 months after using denture. Subjects in the control group completed the cognitive tests at baseline and at follow-up sessions 1 month after pre-prosthetic treatment. Although in the denture group there were improvements in the subjects' cognitive functions between measurements ($p < 0.05$), the control group also showed the same improvements in the cognitive function when compared to the denture group ($p > 0.05$).

Regardless of whether or not the subjects use denture, the better oral health condition due to pre-prosthetic treatment can give a positive impact for the patients' cognitive function.

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Introduction

The population of elderly continues to increase globally, including in Indonesia. Currently in Indonesia 17 million people (8%) are over 60 years old. This age group is estimated to grow to 13.5% of the population by 2025. Age is an important risk factor for dementia.¹ Dementia is a clinical syndrome caused by neurodegeneration (Alzheimer's disease, vascular dementia, Lewy body, and frontotemporal dementia being the most common underlying pathologies) and characterized by progressive deterioration in cognitive ability and capacity for independent living.² Dementia risk is

also estimated to double over the next decades. This is important as it results in dependency and high costs and there is no treatment.¹

Poverty and low levels of education can prevent access to health care, may be associated with less knowledge of the importance of using denture and are also associated with dementia. The data from Depok City, West Java Province again showed that fewer teeth were associated with worse memory. However, when mastication was entered, it showed that this had an independent effect. This may indicate that feeding and a lack of nutrition contributes to memory decline. Foods high in folate and cobalamin, such as green leafy vegetables, legumes and beans, nuts and meats are often chewy and consumption may be reduced in the presence of oral disease. This is further substantiated by observational data showing a decrease in body weight as symptoms of dementia become apparent.¹ This wasting does not occur when feeding is actively promoted. Perhaps by further improving mastication by using denture and oral related health, mental

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health and quality of life will be improved in elderly. Therefore, we hypothesize that improved oral health will result in improved cognitive performance and reduced dementia risk.

In this study we will investigate whether improving mastication ability by using denture in elderly can improve cognitive function in elderly people. The purpose of this study is to enhance the awareness of both elderly people and the government about the importance of oral health and using dentures in improving cognitive functions and the quality of life of elderly people in general.

Materials and methods

This study is a clinical trial with 40 subjects. All subjects were recruited from patients who came toothache hospital of Universitas Indonesia's Faculty of Dentistry to make dentures. Forty elderly subjects who came to the teaching hospital were interviewed and examined. Thirty of the subjects undergone denture treatment and finally used denture. The other subjects were the control group. The control group only underwent preprosthetic treatments such as scaling, filling, and tooth extraction. The design uses repeated measurements and subjects will act as their own controls. In the denture group, each subject will complete a series of cognitive tests at baseline and at follow-up sessions 1 and 2 months after using denture. In the control group each subject will complete a series of cognitive tests at baseline and at follow-up sessions 1 month after pre-prosthetic treatment. After all the assessments for the study have been finished, the control group subjects are then finally given their dentures

Each subject will be involved in the study for approximately 2 months from initially meeting with the providing consent, up until the last follow-up session. Inclusion criteria were elderly aged ≥ 60 years, willing to undergo denture treatment, can communicate with people and were missing more than 10 teeth with loss of occlusion at the time of the study. Besides the inclusion criteria, there are also some exclusion criteria. For this study, we excluded people who have severe systemic illness, cardiovascular diseases, diabetes mellitus, and those who have neurological illnesses or psychiatric disorders which could cause cognitive deficits and mood disorders.

Screening will take place once subjects have consented to take part in the study. The screening procedure will involve obtaining information about the current and past health of the subject and will indicate whether there will be a medical reason why they should not complete the study. Subjects will also be asked questions relating to the exclusion criteria outlined above of this protocol. Screening criteria will generally be assessed by self-report, however, any advice from the dentist or any other healthcare staff involved in recruitment for this study, will also be taken into account.

Subject's scores on cognitive tests will be assessed. The tests can be used as markers for neurological decline as they are sensitive to changes in cognitive function. These tests are expected to take up to 30 minutes to complete in total. The tests used to assess the cognitive functions of the subjects are as follows:

- i) Mini-Mental State Examination (MMSE; Folstein, Folstein & McHugh, 1975). This is a frequently administered paper-and-pencil screening test for dementia and serious cognitive impairment used by both clinicians and researchers. It generally has the best predictive ability when used in combination with other cognitive tests (e.g. Hopkins Verbal Learning TEST; HVLT; outlined below). The MMSE assesses a number of basic cognitions including aspects of memory, attention and language. The tool is scored out of 30, where a score of 24-30 indicates normal levels of cognition, a score of 18-23 indicates mild cognitive impairment and a score of 0-17 indicates severe cognitive impairment³.
- ii) Hopkins Verbal Learning Test (HVLT; Brandt, 1991). This is used to assess verbal episodic short-term memory (immediate recall). Subjects are read aloud a word list, which contains 12 items. The list comprises of 4 words from each of 3 well-known semantic categories (precious stones, human shelter and animals). Subjects are then asked to recall this word list in any order, immediately after the list has been read to them. This procedure is repeated 3 times in consecutive trials. The average number of words recalled across these 3 trials forms the total recall score. This test has been shown to have high sensitivity and specificity in both healthy controls and demented patients⁴. The HVLT was validated for Indonesia⁵

iii) Verbal Fluency. This task is used to measure semantic memory. Subjects are given a category (e.g. 'animals') and are given one minute to name as many words as they can from this category. The score is the total number of words named within this time frame.

All of the data will be subjected to standard parametric statistical analyses using SPSS software. A General Linear Model repeated measures analysis will be employed.

Results

The ethical commission from the Faculty of Dentistry of Universitas Indonesia has already approved this study. Forty elderly subjects who came to the FKG UI teaching hospital were interviewed and examined.

Thirty of the subjects undergone denture treatment and finally used denture. The other subjects were the control group. The control group underwent pre-prosthetic treatments such as scaling, filling, and tooth extraction. The characteristics of the subjects in this study are displayed in Table 1.

Characteristics	N	%
Sex		
Men	18	45
Women	22	55
Education		
Elementary	8	20
Junior Highschool	10	25
Senior Highschool	17	42.50
University	5	12.50
Age		
60-70 years old	26	65
>70 years old	14	35
Type of Denture		
Removable partial denture	27	67.50
Full denture/Single complete denture	13	32.50

Table 1. Characteristics of subjects.

The majority of subjects were women age 60-70 years old, using partial removable denture. The education level of subjects varies from elementary education to university graduates, but mainly they had high school degree. Table 2 below shows the distribution of the observed variables.

	N	Min	Max	Mean	SD
Age	40	60	76	67.62	4.66
HVLT 1*	40	7	23	16.55	4.65
HVLT 2*	40	9	29	18.23	4.74
HVLT 3*	30	13	36	21.73	4.79
MMSE 1 *	40	14	29	23.22	2.97
MMSE 2*	40	20	30	25.10	2.32
MMSE 3*	30	24	30	27.37	1.85
verbal fluency 1*	40	7	23	14.92	3.99
verbal fluency 2*	40	7	22	15.60	3.80
verbal fluency3*	30	10	24	17.43	3.59

*1= baseline *2= 1 month follow up *3= 2month follow

Table 2. Distribution of observed variables.

Table 2 shows that the averages of the HVLT in the baseline and 1 month follow up measurements were below the cut off point, which is 19. It means that the subjects were classified as dementia sufferers. However, the average of the 2 months follow up measurement of HVLT was above the cut off point, which means there was an improvement in the subjects' cognitive function. The results of the MMSE and Verbal Fluency tests also indicate that there were improvements in their cognitive function.

Variables	Denture Group (Mean ±SD)	Control Group (Mean ±SD)
HVLT1	16.93 ±4.95	16.93 ± 4.95
MMSE1	23.30± 3.32	23 ±11.56
Verbal Fluency1	14.50 ± 4.20	14.50±4.20

Table 3. Comparability of control group and denture group.

Table 3 shows that the denture group and the control group had comparable results in the HVLT, MMSE and Verbal Fluency tests at baseline. The mean of HVLT, MMSE and Verbal Fluency measurements at baseline in both groups were also in the range of standard deviation. The effect of denture towards changes of cognitive function at baseline and 1 month follow up measurement are shown below in Table 4.

The table above shows that the denture group and the control group subjects gave the same response in terms of cognitive function improvements between measurements. Table 5 below highlights the changes of cognitive function between measurements in the denture group.

Variables	Mean±SD	P value
HVLT Denture Group		
Baseline	16.93±4.95	
1 month follow up	18.97 ± 4.87	
HVLT Control Group		
Baseline	15.40±3.57	
1 month follow up	16.00±3.65	0.08
MMSE Denture Group		
Baseline	23.30 ±3.32	
1 month follow up	25.57 ±2.37	
Control Group		
Baseline	23 ±1.56	
1 month follow up	23.70±1.49	0.07
Verbal Fluency Denture Group		
Baseline	14.53±4.22	
1 month follow up	15.23±4.03	
Control Group		
Baseline	16.10±3.11	
1 month follow up	16.70±2.91	0.92

*GLM Repeated Measures were used

Table 4. Effect of denture towards changes of cognitive function at baseline and 1 Month follow up measurement.

Variables	Mean±SD	P value
HVLT		
Baseline	16.93± 4.95	0.00*
1 month follow up	18.97± 4.87	
2 month follow up	21.73± 4.79	
MMSE		
Baseline	23.3± 3.32	0.00*
1 month follow up	25.57± 2.37	
2 month follow up	27.37± 1.85	
Verbal Fluency Test		
Baseline	14.53± 4.21	0.00*
1 month follow up	15.23± 4.03	
2 month follow up	17.43± 3.59	

GLM Repeated Measures were used, *p<0.05

Table 5. Changes of cognitive function between measurements in the denture group.

The table above shows improvement of cognitive function between measurements in the denture group. The subjects who were classified as dementia sufferers in the baseline measurements showed improvement in cognitive function and by the 2 month follow up were no longer classified as dementia sufferers.

Discussion

Prevalence rates of dementia across Asian countries range from 0.03% to 33.2%. Across all studies, old age, female gender and low education were the most consistent risk factors for dementia.⁶ Indonesia has the world's 7th largest elderly population, which is expected to double by 2025. It is estimated that between 4 to 6 % of elderly in Indonesia may currently be afflicted with dementia. There will be nearly 1.4 million cases of dementia over the age of 60 by

2025. The study of elderly, memory decline and associated risk factors which included 719 Indonesian elderly from both rural and urban sites concluded that there was no difference in dementia prevalence between men and women in Indonesia. About 55% dementia cases were women.¹ Another study led by the same researcher had also found association between good nutrition, not smoking and good dental health with better cognitive function and less dementia risk in older age. Her cross-sectional study showed that nutrition and smoking can be related to dental health, and in turn, dental health can also affect cognitive ability.¹

A study by Kusdhany et al in Indonesia elderly showed that level of education, age and oral hygiene Index have association with level of cognitive function. In her study, the average score of MMSE test of the elderly (25.26±4.) is higher compare to the average score of MMSE test in our study at baseline measurement (23.3±3.32). The differences may be due to different population. The previous study was done in the community and our study was done in our teaching hospital and the subjects were patients who in need of denture⁷. In our study, the average HVLT in base line and 1 month follow up measurements were below the cut off point, which is 19. It means that the subjects were classified as dementia sufferers. However, the 2 month follow up measurement of HVLT was above the cut off point, which means there was an improvement in the subjects' cognitive function.

The modified HVLT test, which was used in this study had been translated into Bahasa Indonesia and Javanese and was then back translated to English by an independent party.⁸ Memory is one of the earliest function decline in dementia. The total immediate recall test of HVLT has been proven to have high sensitivity and specificity for dementia when assessed in different cohorts in US and UK⁸. Both HVLT and MMSE test was used in our study. Another study about Risk Factors for Possible Dementia Using the Hopkins Verbal Learning Test and the Mini-Mental State Examination in Shanghai also use both tests and they found that a combination of the HVLT and the MMSE can be used to detect possible dementia.⁹

To screen implies the use of sensitive, specific and low cost tool to be administered on large population of healthy people and resulting

accurate identification of preclinical phase of cognitive decline. Recent meta analysis and consensus papers indicated that screening test such as MMSE and verbal fluency test as the most sensitive cognitive test to discriminate normal subjects from people affected by mild cognitive impairment and dementia.¹⁰ In our study we measured cognitive function using MMSE, HVLIT and Verbal fluency test. However using these screening tests also suffer from several biases such as different population with different educational level.¹⁰

Animal studies has shown that mastication maintains cognitive function in the hippocampus, a brain area important for learning and memory. Many epidemiological studies showed that reduced mastication is a risk factor for reduced cognitive function. Active mastication improves performance of sustained cognitive tasks by activating the hippocampus and prefrontal cortex which are important for cognitive processing.¹¹ Takata et al stated based on his study that intellectual activity was improved in individuals who were able to chew hard foods or moderately hard to chew foods. The prevalence of improved intellectual activity was higher in individual with 20 or more teeth.¹²

The result of our study showed that both the subjects who used denture and the subjects who only undergone pre-prosthetic treatment showed improved cognitive function. It means that regardless of whether or not the subjects use denture, the better oral health condition due to pre-prosthetic treatment such as scaling, filling and extraction of residual dental root can give a positive impact for the patients' cognitive function. After pre-prosthetic treatment, subjects felt free of pain so they can masticate with comfort regardless of whether or not they continued with the denture treatment. Our study supports the result of a previous study by Kusdhany (2015). According to this previous study, oral hygiene is related to cognitive function ($p=0.02$) and 74.8% of the subjects with good oral hygiene had MMSE score of more than 24.⁷ In our study, the pre-prosthetic treatment on our subjects has most likely helped in improving their oral hygiene, therefore giving positive impact on cognitive function.

A study about the influence of denture treatment on brain function summarized that denture treatment for complete denture wearers improved not only mastication but also activation

of cerebral function. Wearing partial dentures also increased brain function activation after chewing. The occlusal contact area and occlusal force have influence on brain function.¹³ The result of our study supports the result of the previous study. In the denture group there was improvement of cognitive function between measurements. Many studies also support these results.

Miranda et al in her study found that most of the individuals who showed cognitive impairment were not using dentures and there was a significant association between variables cited. It was verified that the majority of the elderly that revealed cognitive impairment were in need of denture.¹⁴ Another study by Kopplin et al showed that the cognitive status of elderly might be influenced by the quality of their dentures. The quality of dentures, masticatory disability and use of dentures can be considered as an early marker of physical and cognitive status.¹⁵

Furuta et al in his study showed complex pathways from cognitive ability and oral health status via swallowing and nutritional status to the activity of daily living using path analysis. Oral health status directly affects swallowing function and also cognitive impairment and malnutrition.¹⁶ The result of this study supports our findings that better oral health after preprosthetic treatment gave positive impact to cognitive function.

Conclusions

Both the subjects who used denture and the subjects who only undergone pre-prosthetic treatment showed improved cognitive function. It means that regardless of whether or not the subjects use denture, the better oral health condition due to pre-prosthetic treatment such as scaling, filling and extraction of residual dental roots can give a positive impact for the patients' cognitive function.

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Declaration of Interest

The authors report no conflict of interest.

References

1. Hogervorst E, Prasetyo S, Kusdhany L, et al. Optimal Ageing, Dementia, Gender, and Socioeconomic Status. In: Ageing, Gender, Health and Productivity. Jakarta: UI-Press; 2011:68-84.
2. Prince M, Bryce R, Albanese E, Wimo a, Ribeiro W, Ferri CP. The global prevalence of dementia: a systematic review and metaanalysis. *Alzheimers Dement.* 2013;9(1):63-75
3. Vertesi A, Lever JA, Molloy DW, et al. Standardized Mini-Mental State Examination. Use and interpretation. *Can Fam Physician.* 2001;47:2018-2023.
4. Hogervorst E, Combrinck M, Lapuerta P, Rue J, Swales K, Budge M. The Hopkins Verbal Learning Test and screening for dementia. *Dement Geriatr Cogn Disord.* 2002;13(1):13-20.
5. Hogervorst E, Rahardjo TB, Jolles J, Brayne C, Henderson VW. Gender differences in verbal learning in older participants. *Aging health.* 2012;8(5):493-507.
6. Catindig JAS, Venketasubramanian N, Ikram MK, Chen C. Epidemiology of dementia in Asia: Insights on prevalence, trends and novel risk factors. *J Neurol Sci.* 2012;321(1-2):11-16.
7. Kusdhany LS, Rahardjo TB, Agustin D, Masulili C, Lelyati S, Hogervorst E. Oral Hygiene Status and Cognitive Function in Indonesian Elderly. *Int J Clin Prev Dent.* 2015;11(4):261-64.
8. Hogervorst E, Mursjid F, Priandini D, et al. Borobudur revisited: soy consumption may be associated with better recall in younger, but not in older, rural Indonesian elderly. *Brain Res.* 2011;1379:206-12.
9. Xu X, Xiao S, Rahardjo TB, Hogervorst E. Risk Factors for Possible Dementia Using the Hopkins Verbal Learning Test and the Mini-Mental State Examination in Shanghai. *Diagnostics.* 2015;5(4):487-96.
10. Calzà L, Beltrami D, Gagliardi G, et al. Should we screen for cognitive decline and dementia? *Maturitas.* 2015;82(1):28-35.
11. Ono Y, Yamamoto T, Kubo KY, Onozuka M. Occlusion and brain function: mastication as a prevention of cognitive dysfunction. *J Oral Rehabil.* 2010;37(8):624-40.
12. Takata Y, Ansai T, Soh I, et al. Relationship between chewing ability and high-level functional capacity in an 80-year-old population in Japan. *Gerodontology.* 2008;25(3):147-54.
13. Hosoi T, Morokuma M, Shibuya N, Yoneyama Y. Influence of denture treatment on brain function activity. *Jpn Dent Sci Rev.* 2011;47(1):56-66.
14. Miranda LDP, Silveira MF, Oliveira TL, et al. Cognitive impairment, the Mini-Mental State Examination and socio-demographic and dental variables in the elderly in Brazil. *Gerodontology.* 2012;29(2):34-40.
15. Cerutti-Kopplin D, Emami E, Hilgert JB, Hugo FN, Padilha DMP. Cognitive status of edentate elders wearing complete denture: Does quality of denture matter? *J Dent.* 2015;43(9):1071-75.
16. Furuta M, Komiya-Nonaka M, Akifusa S, et al. Interrelationship of oral health status, swallowing function, nutritional status, and cognitive ability with activities of daily living in Japanese elderly people receiving home care services due to physical disabilities. *Community Dent Oral Epidemiol.* 2013;41(2):173-82.