Association between Tooth Loss and the Development of Dementia on the Indonesian Elders

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Research Article

Association between Tooth Loss and the Development of Dementia on the Indonesian Elders

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Abstract

Tooth loss may be a modifiable risk factor for dementia, but the causal relationship has not been evaluatedsufficiently. The purpose of this study was to investigate the association between tooth loss and dementia on the Indonesian elder. The subjects consisted of 208 volunteers (36 males and 172 females) aged 60 years or older. The mini mental state examination (MMSE; score range: 0-30) is used as a screening test for cognitive impairment. In the logistic regression analysis, odds ratio (OR) of cognitive impairment (MMSE score < 23) were 6.34 (95% CI, 2.76 to 14.55) and 2.82 (95% CI, 1.30 to 6.10) for subjects who had remaining < 10 teeth and those who had remaining 11-19 teeth, respectively, when compared with subjects who had remaining > 20 teeth. It can be concluded that tooth loss have association with dementia in Indonesian subjects.

ABBREVIATIONS

MMSE: Mini Mental State Examination

INTRODUCTION

Dementia is a syndrome due to disease of the brain, usually of a chronic or progressive nature, in which there is disturbance of multiple higher cortical functions, including memory, thinking, orientation, comprehension, calculation, learning capacity, language, and judgment. In this syndrome, the impairments of cognitive function are commonly accompanied, and occasionally preceded, by deterioration in emotional control, social behavior, or motivation. Moreover, this syndrome occurs in a large number of conditions primarily or secondarily affecting the brain [1].

Numerous studies have linked dementia to the subsequent deterioration of oral health and the most significant public health problem in ageing community. It is estimated that there are 24.3 million people with dementia worldwide and projected there are 4.6 million new cases raising each year. By the year 2040, it is expected that dementia will influence more than 81 million people worldwide [2]. In the year 2010, the elderly population whose age is more than 60 years in Indonesia is predicted at approximately 19 million, while the actual prevalence of dementia is not known. On the other hand, according to the Alzheimer's disease International projection, the number of dementia in Indonesia was estimated to be 606,100 people in 2005 with annual incidence cases of 191,400. This number was projected to be 1,016,800, with annual new cases of 314,000 by the year 2020 [3,4]. Several studies have reported that tooth loss is may be associated with dementia in elders [5-8]. To our knowledge, however, only a small number of community-based studies have investigated the causal relationships between tooth loss and dementia with cognitive impairment. Further understanding of the modifiable risk factors of dementia will be helpful to reduce the rapid incidence of disease. The purpose of this study was to investigate the association between tooth loss and dementia in an elderly Indonesian population.

MATERIALS AND METHODS

The subjects consisted of 208 volunteers (36 males and 172 females) aged 60 years or older. Fifty three participants (22 males and 31 females) were recruited from Sukabumi rural area while 155 participants (14 males and 141 females) were recruited from urban area from the city of Jakarta (capital of Indonesia) and Depok a satellite of Jakarta. All of the participants were living in their own homes and most of them were able to walk independently. This study was approved by the Ethics Committee of Faculty of Dentistry, Universitas Indonesia. Written informed consent was obtained from each of the subjects before their participation in the study.

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The Mini Mental State Examination (MMSE) is widely used as a global test of cognitive function to screen for dementia and assesses orientation, immediate memory, attention and calculation, short-term recall, and language [9]. Based on the original MMSE, we developed a modified and culturally adapted MMSE according to Indonesian subjects. The MMSE (score range, 0-30) is used as a screening test for cognitive impairment. The Recall test (score range, 0-3) is a sub-item of the IMMSE that evaluates the impairment of recent memory. Subjects were instructed to recall three unrelated objects that they were previously instructed to remember. The MMSE was carried out by two interviewers who were formally trained by a psychiatrist. Cognitive impairment was classified as an MMSE score of less than 24 [9, 10].

A dental examination was carried out by two dentists calibrated regarding the techniques, with the dentist and the subject in a sitting position under artificial lighting. The number of teeth was recorded for each subject. The remaining teeth were defined as healthy, carious, or treated teeth, inclusive of completely erupted third molars. Severe carious teeth and very loose teeth that were indicated for extraction were excluded as remaining teeth. We categorized the remaining teeth as twenty teeth or more, eleven to nineteen, ten teeth or less.

We classified that having the status of hypertension when a participant's having systolic blood pressure of 140 mm Hg or greater and/or diastolic blood pressure of 90 mm Hg or greater. We categorized participant's non-fasting glucose level as 200 mg/dL or over and below than 200 mg/dL.

Statistical analyses were performed using Confidence Interval Analysis Software for Windows (ver. 2.0, Trevor Bryant, University of Southampton). Logistic regression analysis was carried out with low MMSE score as dependent variables and other variables were used as independent variables. The number of remaining teeth was used as continuous variables in one model and categorical variables in the other model.

RESULTS AND DISCUSSION

Results

All of the 208 participants aged 60 years old and above (36 men and 172 women) have completed all the examination processes. The subjects were divided into two groups based on their MMSE scores. The demographic characteristics of subjects, the socioeconomic characteristics and the number of remaining teeth are shown in Table 1.

The mean age (SD) of male and female subjects were 74.4 (8.5) and 66.8 (6.9) years old, respectively. The mean MMSE score (SD) of subjects with low MMSE score (≤ 23) and high MMSE score (≥ 24) were 20.1 (8.8) and 27.0 (2.0), respectively. The proportions of men and women having low MMSE were found 25% (9/36) and 25.6% (44/172), respectively. Subjects living in the rural area were more likely to have a lower MMSE score. The proportions of urban and rural elders having low MMSE were found 20.7% (32/156) and 39.6% (21/53) respectively. Most of subjects with low MMSE were having 6 years or lower education experience (37.8%). The proportion of subjects with low MMSE among 7 – 12 years and ≥ 13 years educational experience groups were 19.4% (21/108) and 5.6% (1/18), respectively. Monthly allowances among subjects with low MMSE was found as low as IDR 512,903 while in the high MMSE group was found as high as IDR 922,288.

The mean (SD) number of remaining teeth in subjects with low MMSE and high MMSE were 14.65 (7.96) and 21.5 (8.02), respectively. In the logistic regression analysis, odds ratio (OR) of cognitive impairment (MMSE score ≤ 23) were 6.34 (95% CI, 2.76 to 14.55) and 2.82 (95% CI, 1.30 to 6.10) for subjects who had remaining ≤ 10 teeth and those who had remaining 11 – 19 teeth, respectively, when compared with subjects who had remaining ≥ 20 teeth.

Discussion

The result of this community-based survey revealed that the

Table 1: Distribution of demographic, socioeconomic, and number of remaining teeth status.

Parameter	Low MMSE (≤ 23)		High MMSE (≥ 24)	
Age (years), mean (SD)	73.45	(8.92)	66.29	(5.38)
Sex, number (%)				
males	9	(25.0)	27	(75.0)
females	44	(25.6)	128	(74.4)
Region, number (%)				
urban	32	(15.38)	123	(59.13)
rural	21	(10.10)	32	(15.38)
Length of education, number (%)				
≥ 13 yrs	1	(5.6)	17	(94.4)
7 - 12 yrs	21	(19.4)	87	(80.6)
≤ 6 yrs	31	(37.8)	51	(62.2)
Allowances (IDR/month), mean (SD)	512,903	(507,452)	1,541,389	(922,288)
Number of remaining teeth, mean (SD)	14.65	(7.96)	21.50	(8.02)

Abbreviations: IDR: Indonesian Rupiah; MMSE: Mini Mental State Examination; SD: Standard Deviation

prevalence of a low MMSE score was significantly associated with low number of remaining teeth. These results are consistent with those of previous studies demonstrating that tooth loss was associated with decreased cognitive function [5,7,8]. Many factors may contribute to cognitive impairment in elders, including cardiovascular disease, education and social economy status [10].

The other main findings of this study are that a low level of education and a low income were significantly associated with low MMSE score and increased risk of dementia. Our results are in agreement with previous findings in a study of education and dementia in a Japanese population[7].Different mechanisms have been suggested to explain this association. Katzman [11] proposed that education might increase brain reserves by increasing synaptic density in the neocortical association cortex. Stern et al. extended the cognitive reserve hypothesis and took into account the possible beneficial influence of mental activity throughout the entire life span, where occupational attainment along with level of education could influence the risk of dementia's disease [12]. It is known that education is an indicator of socioeconomicstatus. This socioeconomic status acting over the life course have been found to affect health and risk of cardiovascular disease. Cumulative economic hardship has been found to lead to poorer cognitive functioning and dementia.

The association between loss of molars and spatial memory deficits was first described in an animal study using senile rats [13]. In that study, after molar extraction, rats were maintained with diet powder and were subjected to behavioral testing to evaluate their spatial memory. Animals with extracted molar teeth showed worse behavioral performance compared to control animals maintained with solid diet. Mastication is the main function of stomatognathic system and the relationship between mastication and the central nervous system (CNS), especially the cognitive area, is still the subject of several studies. Numerous studies have revealed an association between mastication and cognitive functions [10, 13-16]. The possible associations between masticatory hypofunction and cognitive insufficiency have been demonstrated in several animal studies [16-19]. Rats in those studies were induced masticatory hypo function by performing extraction or occlusal reduction of the molar teeth rather than a long-term soft diet [16,17,19]. The occlusal hypo function caused degenerative changes in their periodontal mechanoreceptors [20] suggesting a suppression of sensory stimulation from the periodontal ligament during chewing. In those experiments, animals showed poor performance on memory and learning evaluation.

Histologically, the hippocampus, the main CNS region, that affected by masticatory hypofunction was reported by several studies [16,21]. The hippocampus is included in some kinds of memory, especially which relates to details and precise events [16, 21]. Recently, an animal study using senescence-accelerated mouse prone 8 (SAMP8) examined whether reduced mastication from a young age mice affects hippocampal-dependent cognitive function[22] (Table 2).This study found that loss of masticatory function in early life causes malnutrition and chronic stress and impairs the ability to recognize novel objects. Hyper activation and lateralized rotational behavior are commonly observed with dysfunction of the dopaminergic system, therefore, reduced masticatory function may deplete the mesolimbic and mesocorticolimbic dopaminergic systems to impair the cognitive functions of selective attention and recognition memory in the prefrontal cortex and the hippocampus [22-24].

Table 2: Logistic regression model for predicting lower MMSE scores (≤23).

Variables	OR	95% CI	*P* value
Age			
≤ 65 years (reference)	1.00		
≥ 66 years	8.86	3.76 to 20.87	< 0.05
Sex			
males (reference)	1.00		
females	1.03	0.45 to 2.36	> 0.05
Region			
Urban (reference)	1.00		
Rural	2.52	1.29 to 4.95	< 0.05
Length of education			
13 years or over (reference)	1.00		
7 - 12 years	4.10	0.52 to 32.60	> 0.05
6 years or under	10.33	1.31 to 81.53	< 0.05
Allowances (IDR/month)			
≥ 1,500,000 (reference)	1.00		
< 1,500,000	3.01	1.56 to 5.82	< 0.05
Blood pressure			
Normotension (reference)	1.00		
Hypertension	1.38	0.68 to 2.81	< 0.05
Non fasting glucose level (mg/dL)			
< 200 (reference)	1.00		
≥ 200	0.17	0.02 to 1.29	> 0.05
Number of remaining teeth			
≥ 20 (reference)	1.00		
11-19	2.82	1.30 to 6.10	< 0.05
≤ 10	6.34	2.76 to 14.55	< 0.05

Abbreviations: CI: Confidence Interval; IDR: Indonesian Rupiah; Mg/dL: Milligram per Deciliter; OR: Odds Ratio.

Masticatory dysfunction also leads to various morphologic changes in the hippocampus and cerebral cortex, e.g., the molar less condition and soft-diet feeding decrease the brain cells including synapses in the hippocampus and parietal cortex [25], as well as neurotrophic receptor expression in hippocampal CA1 and CA3 regions[26]. Hypertrophy and hyperplasia of glial fibrillary acid protein-labeled astrocytes in the CA1 region [27, 28] and suppressed cell proliferation in the hippocampal dentate gyrus [29,30]also occur in mice with learning deficits. These behavioral and hippocampal morphologic changes are similar to the changes associated with advanced age [31,32] and masticatory dysfunction may therefore accelerate the aging process in the hippocampus.

Neuroimaging clinical trials using functional MRI and positron emission tomography indicate that several regions of the brain

are activated during mastication, including the cortex, thalamus, striatum, and cerebellum [33-35]. Functional MRI evaluation on neuronal activity in the brain indicated that chewing activity increases the blood oxygen level-dependent signals in the right premotor cortex, precuneus, thalamus, hippocampus and inferior parietal lobe [36]. Furthermore, chewing activity was reported significantly enhances memory in aged subjects [37]. Cerebellar functions also seem to be influenced by masticatory activity [34]. Recently, Quintero and others [38] have reported that the functional connections between cerebellum and cortical areas during masticatory activity [36-38]. It has been well documented that the cerebellum is responsible for motor planning, including the force needed to perform motor tasks. However, it is not clear yet what is the mechanism of reduced input activity due to masticatory dysfunction differ from the effects of a reduction in other types of sensory stimuli in the aging hippocampus. To elucidate the mechanisms underlying the specific effects of masticatory dysfunction in aging hippocampus, it will be necessary to compare the impact of mastication and environmental enrichment or physical exercise on hippocampal function.

CONCLUSION

In summary, there are significant relationships were found between the number of remaining teeth and cognitive function. Edentulism may be predictors of dementia late in life.

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