RESEARCH ARTICLE

Tooth Loss, Occlusal Teeth Support, Salivary Flow Rate, and Food Texture Choice in the Elderly with Cognitive Impairment: A Preliminary Study in Indonesia

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Abstract:
Background: The elderly are at risk of experiencing oral health problems and chewing due to tooth-loss, decreased occlusal teeth support, and decreased salivary flow rate.

Objective: This study aimed to compare distribution and comparison tooth loss, the proportion of occlusal teeth support, salivary flow rate, and the choice of food texture between the normal and cognitive impairment groups.

Methods: Preliminary study and cross-sectional designed method on community-dwelling elderly in Bandung City, Indonesia. The inclusion criteria were no complaint of orofacial pain, not wearing denture prostheses, good communication skills, reading and writing skills, and good physical health. Demographic data include age, gender, education, and occupation. Tooth loss distribution, the proportion of occlusal contact zone, salivary flow rate, and choice of food texture were determined. Cognitive function was measured using the mini mental short examination (MMSE) form. A Mann-Whitney test was used to compare normal and cognitive impairment groups with a significance level of p-value <0.05.

Results: 25 cognitive normals with MMSE score ≥25 and 10 cognitive impairment with MMSE score <25. Mean anterior tooth-loss was 2.16±3.89 vs. 4.90± 4.28 (p<0.05) and posterior tooth loss was 7.12± 5.89 vs 10.40± 4.90, p> 0.05 under normal condition compared with the cognitive impairment groups. Fewer occlusal support zone was found more frequently in cognitive impairment by groups B2, B3, B4, and C according to the Eichner Index classification. Salivary flow rate was 1.2942± 0.5768 vs 1.2755± 0.9811, p> 0.05. The participants in both groups preferred a hard-solid food portion.

Conclusion: The loss of anterior teeth is significantly different. The loss of posterior teeth appeared to be different between the elderly with cognitive impairment compared with the normal groups. The occlusal support zone, salivary flow rate, and the choice of food texture as a meal served were similar between both groups in this study.

Keywords: Tooth loss, Occlusal support zone, Salivary flow rate, Choice of food texture, Cognitive impairment, Fever.

1. INTRODUCTION

Poor oral health among the elderly is evident in a high rate of tooth loss and the prevalence of periodontal disease [1 - 3]. Older people are more likely to lose anterior and posterior teeth. Tooth loss has a negative impact on poor oral health-related quality of life (OHRQoL). The inability to chewing is associated with a decrease in the number of natural teeth [4]. Indonesia is preparing for an aging population. The population aged 60 and over is projected to increase to 33.7 million or 11.8% of the total population in 2025, and in 2035, it will reach 48.2 million, or 15.8% [5]. Based on data from the Indonesian
Basic Health Research 2013 (RISKESDA), it is known that people aged 55-64 years have lost their teeth 10.13, and at the age of 65 years and over have lost their teeth 17.05 [6].

Aging is a risk factor for deteriorating oral function. Toothache is one of the health complaints most frequently reported by the elderly population in Indonesia, which is around 0.8-1.8% [6]. The loss of oral function impacts the quality of life (QoL) [4, 7]. The elderly are also at higher risk of developing xerostomia [8, 9]. These conditions cause poor masticatory performance and chewing ability [4, 10], which impacts the choice of food texture for daily diet and insufficient nutritional intake [11 - 13]. A literature study revealed that decreased masticatory activity can affect cognitive function [14 - 16].

Indonesia is a member of the Association of Alzheimer's Disease International (AADI) in the Asia Pacific region. People with Alzheimer's disease in Indonesia increased as many as people with dementia, in 2015 it reached 1 million people and in 2016 there was an increase of 1.2 million people. As people age, it is estimated that by 2030 people with dementia Alzheimer's disease will reach 1.8 million people and the number of people with dementia Alzheimer's disease in 2050 is estimated to be 4 times higher to 4 million [17].

The link between mastication function and cognition has been explored in human studies, particularly in the elderly [18]. However, there has been no published study for the elderly Indonesian population on this topic. Therefore, this preliminary study aimed to determine the distribution and comparison of tooth loss, the proportion of tooth contact zones, salivary flow rate, and choice of food texture between normal and cognitive impairment in the community-dwelling elderly at Coblong District Bandung, Indonesia.

2. MATERIALS AND METHODS

This cross-sectional study obtained the approval of the Ethics Committee of the Faculty of Medicine, Universitas Padjadjaran Indonesia with registration number 0519010096. Data collection was carried out selectively from two Integrated Services Centre (Posyandu) in Coblong District, Bandung City, Indonesia. There were 35 elderly people aged ≥ 60 years. The inclusion criteria were no complaints of orofacial pain, not wearing denture prostheses, good communication skills, reading and writing skills, and good physical health. The characteristics of the elderly include sex, age, education, and occupation were observed. This study measured and compared the distribution of tooth loss, the proportion of occlusal contact zones, salivary flow rate, choice of food texture, and cognitive score.

2.1. Distribution of Tooth Loss and Occlusal Supporting Zone

The number of tooth loss was recorded. The tooth loss was considered as missing teeth, radix, or the teeth, which were indicated for extraction. Third molars were excluded from the counted tooth. The distribution of tooth loss was divided into two categories; anterior and posterior tooth loss. There are two groups of anterior tooth loss, namely loss of anterior teeth ≤ 3 and 4-12 anterior tooth loss. Likewise, the posterior tooth loss was divided into two groups as well, namely loss of posterior teeth ≤9 and 10-16 posterior tooth loss.

The occlusal contact zone was determined from a dental status recording and assessed by Eichner Index (EI) classification. The Eichner index is based on the presence or absence of an occlusal contact zone in each premolar and molar region. A maximum of four contact zone and at least one tooth in contact with the antagonist were counted [19]. EI classification as followed; the classification was divided into categories groups A, B1-4, and C, as shown in Fig. (1).

2.2. Salivary Flow Rate Assessment

One of the simpler, reproducible, and low-cost tests for salivary flow rate measurement is the Saxon test protocol by Peter [20, 21]. This method is implementable for the elderly. Participants were seated and asked to chew cotton wrapped in sterile gauze for 2 minutes. The specific instructions given were: “Place the pieces of gauze into your mouth and begin chewing as if you were chewing gum. Chew as natural as usual. Do not swallow saliva. After 2 minutes, the gauze and the whole saliva spit it out into a plastic cup.” The production of saliva was calculated by weighing the plastic cup with gauze before and after chewing.

The sample volume of saliva was determined gravimetrically, assuming a specific gravity of 1.0, the weighing (gm/ml) converted into ml/ minute (1gm = 0.001liter =1 ml). Saliva was collected between 10:00 - 15.00 am. Measurement of saliva scale used AEG-80 SM electric analytical balance, which is accurate to 10⁻² gm. The flow rates of all saliva were expressed in ml/min.

2.3. Choice of Food Texture for Daily Serving

The choice of food texture was taken from the data collected (using a modification of the semi-Quantitative FFQ list) based on the physical appearance of food in a daily serving. The lists of types of food served daily, namely regular dishes and special dishes. The participants were asked to choose one type of dish they prefer to serve. Daily serving variations based on how they prepared the food for the meal. These were divided into soft solid food (stirred or boiled) and hard solid food (fried or baked). Food texture was categorized as hard solid if it requires high masticatory activity and food texture was categorized as soft solid if it requires low masticatory activity [22]. In the present study, the regular dish meant hard solid food and the special diet meant soft solid food, respectively.

2.4. A Screening Tool for Cognitive Function

MMSE is a global screening tool for cognitive function and has been used in the previous study elsewhere on the topic of mastication and cognitive function [23 - 26]. We used MMSE as screening tools in this study. The cognitive function category was divided into two based on the cutoff > 25 normal and ≤ 25 was cognitive impairment, respectively.
3. RESULTS

Based on the MMSE cognitive score in 35 participants, there were 25 subjects normal and 10 subject cognitive impairment. Table 1 showed demographic data of 35 participants. There were no significant differences in participant’s characteristics in both groups, the normal and the cognitive impairment, except education ($p=0.006$, $p<0.05$).

Table 1. Characteristic participants based on MMSE score categories.

<table>
<thead>
<tr>
<th>Demography</th>
<th>Total Sample N = 35</th>
<th>Normal n = 25</th>
<th>Cognitive Impairment n= 10</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex†</td>
<td>Male 10 (28.6%)</td>
<td>Male 7 (28%)</td>
<td>Male 3 (30%)</td>
<td>0.906</td>
</tr>
<tr>
<td>Age††</td>
<td>60 – 93; 69.66</td>
<td>60 – 93; 69.16</td>
<td>61 – 83; 70.90</td>
<td>0.410</td>
</tr>
<tr>
<td>Min–max; mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edu††</td>
<td>0 – 16; 8.31</td>
<td>6 – 16; 9.36</td>
<td>0 – 9; 5.70</td>
<td>0.006*</td>
</tr>
<tr>
<td>Min-max; mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. (1). Table of groups of Eichner Index [19].
We investigated the distribution of tooth loss according to their position as the anterior and the posterior tooth loss, EI classifications, choice of food texture, and salivary flow rate in the groups were compared. There was a higher significance of anterior tooth loss in the cognitive impairment group compared to the normal cognitive group, p<0.05. (Table 2)

We observed the proportion of the choice of food texture and salivary flow rate also in the tooth-loss category without taking into account the cognitive score as presented in Table 3. The subject preferred the portion of hard solid food (92%) to be served daily in the ≤3 anterior tooth loss group and the portion of soft solid food (55.6%) in the 4-12 anterior tooth loss group. There was a significant difference in daily serving choice between hard solid and soft solid foods in the variability of anterior tooth loss diversity, p=0.002 (p<0.05). The results were similar for posterior tooth loss with a significant difference, p=0.007 (p<0.05), in choosing daily dishes between hard solid and soft solid foods.

Table 2. Description of variables based on the MMSE score categories.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total Sample N = 35</th>
<th>Normal cognitive N = 25</th>
<th>Cognitive impairment N = 10</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tooth loss (mean, SD)††</td>
<td>2.9±4.1 8.1±5.8</td>
<td>2.2±3.9 7.1±5.9</td>
<td>4.9±4.3* 10.4±4.9</td>
<td>0.099* 0.075</td>
</tr>
<tr>
<td>Eichner Index (%) ^</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>7 (20)</td>
<td>6 (24)</td>
<td>1 (10)</td>
<td>0.650</td>
</tr>
<tr>
<td>B1</td>
<td>7 (20)</td>
<td>6 (24)</td>
<td>1 (10)</td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td>6 (17.1)</td>
<td>4 (16)</td>
<td>2 (20)</td>
<td></td>
</tr>
<tr>
<td>B3</td>
<td>3 (8.6)</td>
<td>2 (8)</td>
<td>1 (10)</td>
<td></td>
</tr>
<tr>
<td>B4</td>
<td>9 (25.7)</td>
<td>5 (20)</td>
<td>4 (40)</td>
<td></td>
</tr>
<tr>
<td>The choice of food texture (%) †</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft solid food</td>
<td>7 (20.59) 27 (79.41)</td>
<td>4 (16.67) 20 (83.33)</td>
<td>3 (30.00) 7 (70.00)</td>
<td>0.381</td>
</tr>
<tr>
<td>Hard solid food</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salivary flowrate (mean, SD) ††</td>
<td>1.288±0.6998</td>
<td>1.2942±0.5768</td>
<td>1.2755±0.9811</td>
<td>0.688</td>
</tr>
</tbody>
</table>

We examined the distribution of the tooth loss according to their position as the anterior and posterior tooth loss, EI classifications, choice of food texture, and salivary flow rate in the groups were compared. There was a higher significance of anterior tooth loss in the cognitive impairment group compared to the normal cognitive group, p<0.05. (Table 2)

We observed the proportion of the choice of food texture and salivary flow rate also in the tooth-loss category without taking into account the cognitive score as presented in Table 3. The subject preferred the portion of hard solid food (92%) to be served daily in the ≤3 anterior tooth loss group and the portion of soft solid food (55.6%) in the 4-12 anterior tooth loss group. There was a significant difference in daily serving choice between hard solid and soft solid foods in the variability of anterior tooth loss diversity, p=0.002 (p<0.05). The results were similar for posterior tooth loss with a significant difference, p=0.007 (p<0.05), in choosing daily dishes between hard solid and soft solid foods.

Table 3. Description of food texture selection and salivary flowrate in tooth loss category without cognitive score assessment.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Anterior tooth-loss N=34</th>
<th>p-value</th>
<th>Posterior tooth-loss N=34</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>The choice of food texture (%) †</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft solid food</td>
<td>8(2) 92(23)</td>
<td>55.6 (5) 44.4(4)</td>
<td>0.002* 0.007*</td>
<td></td>
</tr>
<tr>
<td>Hard solid food</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salivary flowrate (mean,SD) ††</td>
<td>1.3340 0.7408</td>
<td>1.1583 0.5831</td>
<td>0.257 0.7394</td>
<td>1.4711 0.5525</td>
</tr>
</tbody>
</table>
Salivary flow rate in the ≤ 3 groups anterior tooth loss was higher than in the 4-12 groups anterior tooth loss, p> 0.05. In contrast, there was a decrease in salivary flow rate in the posterior 10-16 tooth loss group compared with the ≤ 9 posterior tooth loss group, p< 0.05 as shown in Table 3.

4. DISCUSSION

This study was the first exploration of the tooth loss distribution, Eichner Index (EI) classification proportion, salivary flow rate, choice of food texture on the two groups based on the MMSE score in the community-dwelling elderly in Indonesia. The result will give important information for continuing the prospective study in the future. There was no significant difference in the characteristics of the participants in age and gender for normal and cognitive impairment groups, p>0.05. We found the level of education was significantly lower in the cognitive impairment group (p=0.006, p<0.05).

There were variations in the level of education in this community from uneducated to university level. The average education level was 8.31 years. Our study shows the cognitive impairment group has a lower level of education, by an average of 5.70 years. We found significantly higher anterior tooth loss in the cognitive impairment groups (p<0.05) and showed a higher tendency of posterior tooth loss compared with the normal groups (10.4±4.9 vs 7.1±5.9), p> 0.05. As we mentioned earlier, we investigated the position of tooth loss to determine the distribution of tooth loss occurring in the cognitive impairment group due to an increase in recent studies on tooth status or the number of teeth and cognitive decline [25, 27 - 30]. One study conducted by Takeuchi et al. demonstrated an association between posterior tooth occlusion and cognitive function [31]. In our study, we found that the cognitive impairment group had a higher anterior tooth loss and they had a lower education level as well.

A study in Indonesia conducted by Umniyati et al. revealed a link between age, anterior tooth loss, and posterior tooth loss, and quality of life. Respondents are mostly women (86%) and have low education (67%). Furthermore, there was no relationship between gender, employment status, and education level with the quality of life [32]. Another study by Kusdhany et al. showed that 6.78% of respondents had academic and university degrees, but the results explained that there was no correlation between age and education level with OHR-QoL [33]. These results support our data which shows that most of the respondents still have a low level of education. Low education level will result in a lack of good source income, limited access to oral health information, and delay in visiting dentists. In this community-dwelling elderly, oral health has not become a priority in their life. So, that it will have an impact on low OHR-QoL.

Another similar study in Jordan by A-Omri et al. revealed that tooth loss has an impact on the level of satisfaction with their appearance, pain levels, oral comfort, general performance, and capacity to eat in daily living [34]. Another Brazilian study divided loss of teeth into anterior tooth loss and posterior tooth loss performed by Batista et al. The results showed that tooth loss of up to 12 teeth including the anterior teeth resulted in a higher oral health index profile (OHIP) score compared to those who lost 12 teeth but only the posterior teeth. The position of the tooth loss determines the quality of life rather than the number of teeth alone [35]. A study revealed that oral health-related quality of life (OHR-QoL) did not depend on the number of tooth loss due to a weak correlation (r=-0.133, p= 0.041) [33]. A previous review study by Gerritsen et al. stated that tooth loss is associated with impairment of OHR-QoL and distribution of tooth loss affects the severity of impairment [7].

From most of the studies, the proportion of female is higher than men due to the possibility of the female having a long life expectancy. This condition impacts our data which shows a higher proportion of females than males in cognitive impairment compared to the normal groups. The significant correlation between the number of anterior tooth loss and appearance, oral comfort, general performance, and eating dimension indicated that females felt more influence on appearance, comfort, and eating capacity. While on the other hand, females experience partial tooth loss, including loss of anterior teeth, which is higher than males. Factors that influence the perception of a person’s quality of life are age, gender, and education [34]. These factors can differ in Indonesia compared to other studies in other countries, possibly due to differences in the way of thinking, education, and social-economic factors [33].

Our data reports the low education of the elderly and most of the respondents were housewives. It may lead to a lack of source of income. This condition impacts a visit to the dentist and is delayed for the treatment of removable or fixed denture treatment (Pontic). Also, a mindset that prioritizes general health with systemic disease often affects the elderly such as hypertension, diabetes, arthritis, etc. Making a denture is still quite expensive. We found that elderly with low education levels have decreased cognitive function and may not care about aesthetic value.

The observation of posterior tooth loss was constrained by the number of samples. However, observing contact occlusion with EI classification revealed that there was more tooth loss and less occlusal support zone in the cognitive impairment group, p>0.05. The elderly who experiences more tooth loss will have an impact on masticatory force decline. The occlusal force can change to be lower in people who have lost occlusal contact. Furthermore, a decrease in occlusal force causes a change in masticatory force. The sequence of masticatory movement and decreased masticatory force may lead to improper cerebral blood circulation. The cerebral blood circulation is influenced by the input of sensory neuron that comes to generate motor commands that control biting force and masticatory movement patterns [36]. The occlusal force will provide feedback control due to changes in the physical properties of food changes [37]. This condition can cause severe cognitive impairment that already exists or can increase the risk of cognitive decline in later life [38 - 40].

Based on the cognitive scores obtained through the MMSE measurement, there was no significant difference in the choice of hard-solid or soft-solid foods between the normal and impaired groups, p>0.05, as well as results of salivary flow rates according to the cognitive test explaining that there was
The previous studies showed differences in masticatory pattern in the masticatory force. The elderly chose hard solid foods involved in masticatory process and is related to the level of reduction in the function of mastication due to reduced number of teeth and the occlusal supported zone will cause a decrease in the function of mastication due to reduced tooth loss compared to the group with less posterior tooth loss, p=0.007 (p<0.05). The Elderly preferred to serve a portion of hard-solid food for daily meals when they lose fewer anterior teeth and the pattern will change into a portion of soft solid food when more anterior teeth have lost. However, the elderly preferred only one portion of hard-solid food to be served daily regardless of the conditions of posterior tooth loss appearing in the oral cavity.

As we all know, the posterior teeth provide the function for grinding the food. The saliva will moisten the food as it chews it into a bolus [22]. In our study, we showed a significant reduction in salivary flow rate in the group with more posterior tooth loss compared to the group with less posterior tooth loss, p<0.05 as shown in Table 3. We have found an association between masticatory activity and salivary secretion called masticatory-salivary reflex in most studies [9, 20, 42 - 44]. Our study is in line with a previous study in Japan which revealed a decrease in salivary flow rate associated with an occlusal decline [43]. Similar results were carried out by Ikebe et al. in another study that described a lower salivary flow rate in posterior tooth-loss [45].

The number of natural teeth in the oral cavity has an important role in the mastication process and masticatory force. The masticatory force will lead a signal to stimuli oxygen blood flow in selective brain areas. Stimulation of jaw movement and muscle contraction while chewing gum leads to increased blood oxygenation level-dependent (BOLD) in some of the brain regions. Chewing resulted in a bilateral increase of signal in the sensorimotor cortex, supplementary motor area, insula, thalamus, and cerebellum [37, 46 - 48]. Chewing maintenance hippocampus and alternated to prevent cognitive decline in humans.

Mastication function decline can be compensated by a longer duration of mastication and a softer diet [45, 49 - 52]. Reduced number of teeth and the occlusal supported zone will cause a decrease in the function of mastication due to reduced masticatory force [43, 45, 53]. The masticatory force is involved in masticatory process and is related to the level of food texture [53, 54]. Unfortunately, this study did not assess the masticatory force. The elderly chose a hard solid foods portion in both the normal and cognitive impairment groups. The previous studies showed differences in masticatory pattern semi-solid, soft-solid, and hard-solid foods in the elderly [53, 55].

The limited number of subjects has not provided a comprehensive feature of the oral health condition in the elderly. We found that the condition of resigation due to old age causes a less problematic response with tooth loss and even anterior tooth loss. The elderly did not mind appearance and function when it involves loss of posterior teeth. The elderly’s knowledge in this study was low level, possibly having an impact on awareness of behavior in maintaining oral health, treatment, and rehabilitation effort, and so on. Without realizing it, they will experience chewing problems, decreased cognitive function, and lower quality of life.

Further study is needed to explain the findings that elderly with low education experience impaired cognition and do not pay attention to their oral health performance.

CONCLUSION

The loss of anterior teeth is significantly different. The loss of posterior teeth appeared to be different between the elderly with cognitive impairment compared with the normal groups. The occlusal support zone, salivary flow rate, and the choice of food texture as a meal served were similar between both groups in this study.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The protocol of the study was approved by the Institutional Ethics Committee of Universitas Padjadjaran, Indonesia, under approval number 302/ UN6.KEP/EC/2019.

HUMAN AND ANIMAL RIGHTS

No animals were used in this study. All human study procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PARTICIPATION

Written informed consent was obtained prior to participation in this study.

AVAILABILITY OF DATA AND MATERIALS

Not applicable

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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Tooth Loss, Occlusal Teeth Support


