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The Negative Effects of Cognitive Impairments on the Oral Hygiene Status of Hospitalized Older Patients

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Abstract

The purpose of this study was to identify which cognitive impairments negatively affect oral hygiene status. The participants were 411 patients admitted to a hospital's convalescent ward. Investigation item scores were compared among the plaque score groups and tongue coating score groups. Additionally, to examine factors associated with plaque score or tongue coating score, multiple stepwise regression analysis was performed. In the independent brushing group, the functional independence measure [FIM] score of problem-solving was independently associated with plaque score. Additionally, memory score was independently associated with tongue coating score. In the assisted brushing group, the expression score was independently associated with tongue coating score. The cognitive impairments of problem-solving and memory could negatively influence the oral hygiene status of independent brushing patients. In addition, verbal communication ability could be related to tongue coating status in the assisted brushing group.

Keywords: *Oral hygiene; Dental plaque; Tongue coating; Cognitive function*

Abbreviations: If there are any abbreviations in the article, they have to be mentioned

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Introduction

A relationship between oral hygiene status and pneumonia has been reported previously [1-6]. An intervention study demonstrated that both tooth brushing after every meal and professional oral care in nursing home residents once a week significantly reduced the incidence of pneumonia [6]. Accordingly, the Healthcare Infection Control Practices Advisory Committee and the Centers for Disease Control and Prevention in the United States of America issued a general guideline for preventing pneumonia that recommended developing and implementing a comprehensive oral hygiene program [7]. However, many patients in hospitals still have poor oral hygiene [8]. Patients with impaired cognitive function particularly tend to have poor oral hygiene status. Because such patients usually cannot cooperate well, are unable to keep their mouth open, and strongly resist mouth cleaning, medical staff experience difficulty performing adequate mouth

cleaning [9]. But, even though oral care for some cognitively impaired patients is not so difficult, they often present with poor oral hygiene status. This indicates that another reason exists as to why patients with cognitive impairment tend to have poor oral hygiene. However, it is unclear how or whether oral health conditions and cognitive status are related [10]. This study aims to reveal which cognitive impairments negatively affect oral hygiene status. The results may provide useful indicators of which patients are most likely to have poor oral hygiene and need to receive regular professional oral care. This study's ultimate goal is to contribute to improving the oral hygiene status of inpatients.

Patients and Methods

Patients

Up to 411 patients were admitted to the convalescent ward of a hospital in Japan from January to December 2015. Upon admission, their physical and cognitive functions, such as ability to maintain a sitting posture on a chair, ability to grip and move a toothbrush, and ability to understand the meaning of mouth cleaning were assessed by a nurse. This assessment determined whether participants were considered capable or incapable of brushing their own teeth independently.

Methods

A dental hygienist with more than 25 years' experience investigated the following items for each hospitalized patient within 1 week of admission.

Oral hygiene status: Oral hygiene status was measured using each patient's plaque score [11] (2 = plaque or debris generalized along the gum line or denture-bearing area, 1 = plaque or debris in a localized area, i.e., between teeth if present, 0 = clean and no debris), and their tongue coating score (2 = tongue coating covers more than two-thirds of the tongue dorsal surface, 1 = tongue coating covers less than two-thirds of the tongue dorsal surface, 0 = tongue coating covers less than one-third of the tongue dorsal surface, or no coating is visible) [12].

Occlusal status: Occlusal status was measured using Eichner's index (class A = a maximum of four supporting zones, class B = one to three supporting zones or tooth contact in the frontal area only, class C = no supporting zones).

Communication method: 2 = verbal, 1 = writing or gesture, 0 = impossible.

Ability to rinse mouth: 1 = possible, 0 = impossible.

Upper limb disorder: 3 = no limb disorder, 2 = left upper limb disorder, 1 = right upper limb disorder, 0 = bilateral upper limb disorder.

Oral intake status: 1 = possible, 0 = impossible.

Activities of daily living (ADL): Upon admission, an occupational therapist was assigned to the patient and evaluated the patient's ADL levels by using the functional independence measure (FIM). The FIM comprises 18 items, each with a maximum score of 7 and a minimum score of 1 [13]. The 18-item FIM can be divided into 13 items that assess motor ADL and five items that assess cognitive ADL. Cognitive ADL items include two items for communication (comprehension and expression), and three items for social cognition (social interaction, problem-solving, and memory).

Statistical analysis

Investigation items were compared by one-way analysis of variance or the Kruskal-Wallis test among two groups: the plaque score and tongue coating score groups. To compare the plaque score or tongue coating score with the investigation item scores, Spearman's rank correlation coefficients (ρ) were calculated. In addition, to examine factors associated with plaque score or tongue coating score, multiple stepwise regression analysis was performed. Multiple stepwise regression analysis was also used to investigate which cognitive item (comprehension, expression, social interaction, problem-solving, and memory) displayed the strongest association. $P < 0.05$ was considered statistically significant. SPSS Statistics 22 Software (IBM Corporation, NY, USA) was used for statistical processing.

Ethical considerations

This study was approved by the Shin-yachiyo Hospital Ethics Committee (Approval no.: 16-003). Written and oral consent was obtained from all participants or their families.

Results and Discussion

Results

We collected data from 411 patients (221 men), who had a mean age ± SD of 72.6 ± 14.4 years. The primary diseases on admission were cerebrovascular disease (n = 190), cardiac disease (n = 13), respiratory disease (n = 29), neurological disease (n = 15), orthopedic disease (upper body) (n = 11), orthopedic disease (lower body) (n = 113), and other disease (n = 40). Up to 291 patients could brush their own teeth independently (independent brushing group), while 120 patients needed some or full assistance (assisted brushing group) (Table 1).

Investigation items		Independent brushing	Assisted brushing	P-value
Age	mean ± SD, years	69.9 ± 14.6	79.3 ± 11.4	<.001*
Sex	male/female, n	154/137	67 / 53	.590
Eichner index	A/B/C, n	200/60/31	54/34/32	<.001†
Communication method	2/1/0, n	287/4/0	65/44/11	<.001†
Rinse mouth	1/0, n	286/5	44/76	<.001♯
Upper limb disorder	3/2/1/0, n	200/44 /47/0	61/26/24/9	<.001♯
Oral ingestion	1/0, n	279/12	55/65	<.001♯
FIM motor items	mean ± SD, score	53.0 ± 19.7	21.6 ± 14.5	<.001*
FIM cognitive items	mean ± SD, score	27.0 ± 7.1	12.7 ± 7.6	<.001*
Plaque score	0/1/2, n	192/81/13	59/41/9	.016†
Tongue coating score	0/1/2, n	63/204/24	4/95/21	<.001†
*two sample t-test P < 0.05		†Mann–Whitney U test P < 0.05		
♯Chi-squared test P < 0.05				

Table 1: *Patient characteristics.*

Independent brushing group

We excluded five edentulous patients from the plaque score evaluation. Comparison of the three groups according to plaque score revealed significant differences in age and FIM total score for motor and cognitive items. Age (ρ = 0.148) and FIM total score for motor items (−0.138) and cognitive items (−0.218) revealed significant correlations with plaque score. In addition, multiple stepwise regression analysis revealed that the FIM total score for cognitive items [standard partial regression coefficient (β) (P value): −0.239 (< 0.001)] was independently associated with plaque score (Table 2). Among the FIM cognitive items, problem-solving score [β (P value): −0.245 (< 0.001)] was independently associated with plaque score.

Comparison of the three groups according to tongue coating score revealed significant differences in age, oral intake status, and FIM total scores for motor and cognitive items. Age (ρ = 0.161) and FIM total scores for motor items (−0.245) and cognitive items (−0.267) were observed to be significantly correlated with tongue coating score. In addition, multiple stepwise regression analysis revealed that the FIM total scores for motor items [β (P value): −0.160 (< 0.013)] and cognitive items [−0.196 (< 0.002)] were independently associated with tongue coating score (Table 3). Among the FIM cognitive items, memory score [β (P value): −0.254 (< 0.001)] was independently associated with tongue coating score.

Plaque score		0	1	2	P-value	ρ (P-value)	β (P-value)
Age	mean ± SD, years	70.0 ± 14.7	73.8 ± 11.5	72.5 ± 10.2	.009†	.148 (.012)♯	-
Sex	male/female, n	100/92	41/40	9/4	.730		
Eichner index	A/B/C, n	139/38/15	51/22/8	10/0 /3	.370	.075 (.207)	
Communication method	2/1/0, n	188/4/0	79/2/0	13/0/0	.529	−.037 (.530)	
Rinse mouth	1/0, n	191/1	78/3	13/0	.101		
Upper limb disorder	3/2/1/0, n	130/30/32/0	58/12/11/0	7/2/4	.988		
Oral intake status	1/0, n	186/6	76/5	13/0	.454		
FIM motor items	mean ± SD, score	53.2 ± 19.5	50.1 ± 19.3	46.7 ± 21.8	.077	−.138 (.019)♯	
FIM cognitive items	mean ± SD, score	27.0 ± 7.1	25.5 ± 7.0	21.1 ± 8.7	.000†	−.218 (<.001)♯	−.239 (<.001)*
	†one-way analysis of variance P < 0.05			♯Spearman's rank correlation coefficients P < 0.05			
				*multiple stepwise regression analyses P < 0.05			

N = 286

Table 2: *Comparisons of investigation items among plaque scores in the independent brushing group.*

Tongue coating score		0	1	2	P-value	ρ (P-value)
Age	mean ± SD, years	66.8 ± 15.2	70.3 ± 14.5	75.1 ± 12.0	.048†	.161 (.006)♯
Sex	male/female, n	29/34	112/92	13/11	.286	
Eichner index	A/B/C, n	45/15/3	137/42/25	18/3/3	.224	.024 (.686)
Communication method	2/1/0, n	63/0/ 0	201/3/0	23/1/0	.153	−.084 (.153)
Rinse mouth	1/0, n	63/0	199/5	24/0	.515	
Upper limb disorder	3/2/1/0, n	47/7/9/0	137/35/32/0	16/2/6/0	.552	
Oral intake status	1/0, n	63/0	194/10	22/2	.044‡	
FIM motor items	mean ± SD, score	59.9 ± 17.1	52.6 ± 19.5	38.8 ± 20.9	<.001†	−.245 (<.001)♯
FIM cognitive items	mean ± SD, score	29.8 ± 6.0	26.8 ± 7.0	22.0 ± 7.4	<.001†	−.267 (<.001)♯
	†one-way analysis of variance P < 0.05			♯Spearman's rank correlation coefficients P < 0.05		
	‡Kruskal–Wallis test P < 0.05			*multiple stepwise regression analyses P < 0.05		

Table 3: *Comparisons of investigation items among tongue coating scores in the independent brushing group.*

Assisted brushing group

We excluded 11 edentulous patients from the plaque score evaluation. Comparison of the three groups according to plaque score revealed significant differences in Eichner's index. However, a significant correlation with plaque score was not found (Table 4).

Comparison of the three groups according to tongue coating score revealed significant differences in communication method and FIM total score for cognitive items. Furthermore, communication method (ρ = −0.243) and FIM score for cognitive items (−0.272) were revealed to be significantly correlated with tongue coating score. In addition, by multiple stepwise regression analysis, the FIM score of cognitive items [β (P value): −0.257 (0.005)] was revealed to be independently associated with tongue coating score. Among the cognitive items for FIM, the expression score [−0.285 (0.002)] was also found to be independently associated with tongue coating score. (Table. 5)

Plaque score		0	1	2	P-value	ρ (P-value)	β (P-value)
Age	mean ± SD, years	76.6 ± 12.3	81.5 ± 9.8	75.6 ± 8.4	.076	.121 (.208)	
Sex	male/female, n	36/23	23/18	5/4	.603		
Eichner index	A/B/C, n	34/14/11	19/12/10	1/8/0	.029‡	.155 (.291)	-
Communication method	2/1/0, n	34/22/3	21/13/7	4/5/0	.443	−.107 (.268)	
Rinse mouth	1/0, n	22/37	15/26	3/6	.859		
Upper limb disorder	3/2/1/0, n	27/15/13/4	24/7/7/3	4/3/1/1	.755		
Resistive behavior	2/1/0, n	49/10/0	34/6/1	5/4/0	.437	−.107 (.268)	
Oral ingestion	1/0, n	30/29	18/23	3/6	.305		
FIM motor items	mean ± SD, score	22.0 ± 13.9	21.9 ± 17.1	21.1 ± 11.6	.984	−.043 (.660)	
FIM cognitive items	mean ± SD, score	12.9 ± 7.9	12.6 ± 7.7	12.0 ± 6.9	.944	−.022 (.817)	
	‡Kruskal–Wallis test P < 0.05						

N = 109

Table 4: *Comparisons of investigation items among plaque scores in the assisted brushing group.*

Tongue coating score		0	1	2	P-value	ρ (P-value)	β (P-value)
Age	mean ± SD, years	70.5 ± 21.9	79.7 ± 10.7	79.0 ± 12.2	.288	.026 (.780)	
Sex	male/female, n	2/2	55/40	10/11	.508		
Eichner index	A/B/C, n	1/1/2	48/23/24	5/10/6	.114	.094 (.310)	
Communication method	2/1/0, n	2/2/0	57/32/6	6/10/5	.014‡	−.243 (.008)♯	-
Rinse mouth	1/0, n	2/2	38/57	4/17	.063		
Upper limb disorder	3/2/1/0, n	2/1/1/0	52/17/19/7	7/8/4/2	.326		
Resistive behavior	2/1/0, n	4/0	76/18/1	17/3/1	.492	−.038 (.682)	
Oral ingestion	1/0, n	2/2	48/47	5/16	.061		
FIM motor items	mean ± SD, score	16.5 ± 5.7	22.6 ± 15.5	17.8 ± 9.4	.304	−.109 (.234)	
FIM cognitive items	mean ± SD, score	18.8 ± 11.3	13.2 ± 7.6	9.1 ± 5.4	.018†	−.272 (.003)♯	−.257 (.005)*
	†one-way analysis of variance P <0.05			♯Spearman's rank correlation coefficients P < 0.05			
	‡Kruskal–Wallis test P < 0.05			*multiple stepwise regression analyses P < 0.05			

N = 120

Table 5: *Comparisons of investigation items among tongue coating scores in the assisted brushing group.*

Discussion

Many risk factors leading to poor oral hygiene status have been reported previously. Individual risk factors include mouth cleaning methods [14], admission to hospital [15], chronic sensory and motor impairment [16], stress [17], salivary dysfunction, polypharmacy, medical conditions, functional dependence [18], difficulties with rinsing, spitting and swallowing [9], and cognitive impairment [9,10,18,19]. There have been many research reports on the relationship between cognitive function and oral health. However, Cognitive functions have not been classified in detail in previous research and it is unclear which cognitive function is strongly related to the oral hygiene. This study revealed which cognitive impairments adversely affect oral hygiene status.

Independent brushing group

Many patients had a poor plaque score regardless of independent mouth cleaning. This may have been due to how their cognitive functioning, especially problem-solving ability, is related to their oral hygiene status. Although this study could not clarify the exact nature of this relationship, we speculate that patients with problem-solving ability impaired cannot ask for assistance with mouth cleaning and nurses may not notice that it is difficult for them to properly clean the mouth. Therefore, such patients should have their oral hygiene status checked regularly, even if they are assessed as being able to brush their own teeth independently on initial assessment.

Tongue coating comprises desquamated epithelial cells released from the oral mucosa, leukocytes from periodontal pockets, blood metabolites, nutrients, and bacteria [20,21]. The microbiota of saliva has been observed to be most similar to that of the dorsal and lateral surfaces of the tongue [22]. Additionally, a group of patients with no tongue coating has been found to develop pneumonia at 0.12 times the rate of a group of patients with tongue coating [23]. This finding suggests that tongue coating, along with dental plaque, may act as a reservoir of potential respiratory pathogens.

Tongue coating has been suggested to be related to smoking, saliva, periodontal status, dietary habits, and oral hygiene status, with oral hygiene status holding the strongest association [24]. In our study, oral hygiene status had possibly worsened due to a decline in motor and memory ability, which may have negatively influenced tongue coating score. If a person's motor function is declining, their mouth cleaning activity could be restricted; additionally, if their memory ability is declining, this could cause one to forget to clean their mouth frequently. Thus, their mouth cleaning could be prone to inadequacy because of a decline in their abilities, and the bacteria on the dorsum of the tongue accumulate as tongue coating.

This study suggests that the patients who are most likely to experience deteriorated oral hygiene status are not only patients with severe dementia, but also patients with mild dementia who experience declining problem-solving ability or memory because they are expected to manage their oral hygiene without assistance. Impaired problem-solving ability and impaired memory could be useful indicators of older patients who need their oral hygiene status checked more regularly and who should receive more regular oral care.

Assisted brushing group

In this study, the FIM total scores for cognitive items were not significantly associated with plaque score. Plaque has been reported to increase in patients with impaired cognitive function [10,18,19]. To explain this increase, if the cognitive functions of such patients are low, medical staff need to allocate extended time and greater effort to providing adequate oral care due to patients' lack of cooperation [9]. However, in recent years, most medical staff thoroughly understand the importance of oral care, to the extent that even if a patient is unable to cooperate, staff clean patients' oral cavities over time. Therefore, such a modern medical system could contribute to maintaining patients' oral hygiene status to healthier levels, even among patients with decreased cognitive function.

Conversely, communication method and the FIM score of cognitive items were significantly associated with tongue coating score. Furthermore, among the cognitive items, expression score was most strongly associated with tongue coating score. Kikutani., *et al*. suggested that tongue pressure and the frequency of oral diadochokinesis measured by pronouncing the single syllable 'ka' were statistically significantly correlated with degree of tongue coating [25]. Therefore, because patients with verbal communication disability have few opportunities to move their tongues, tongue coating can easily develop.

This study had several limitations. First, the research was conducted at only one hospital in Japan; therefore, our results may have been affected by the specific characteristics of this hospital or region, or differences in national character. Thus, our results cannot be generalized to other hospitals or other countries. Second, we assessed oral hygiene status using simplified plaque and tongue coating scores so as not to rule out patients who were unable to cooperate. Therefore, our information was limited about which areas of the teeth were covered with dental plaque and what kind of bacteria were present in the tongue coating. Thus, we plan to conduct an additional experiment using a more detailed index to reveal the relationship between oral hygiene status and cognitive status in the future.

Conclusion

In conclusion, declining cognitive functions, especially those of problem-solving ability and memory, could negatively influence the oral hygiene status of independent brushing patients. In addition, verbal communication ability could be related to tongue coating status in the assisted brushing group. These functions may serve as useful indicators of which patients are most likely to have poor oral hygiene status. When there are patients with impairment of these functions, regular check of oral hygiene and intervention of professional oral care should be considered. Future research should investigate how many people with poor oral hygiene status are detected by these indicators, and whether the incidence of oral disease and pneumonia is reduced if this population are encouraged to receive regular checks and oral care in hospitals.

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Conflict of interest

None

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