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ORIGINAL ARTICLE

Relationship of “Tooth Condition” with Mobility and Cognitive Function of Residents in Special Elderly Nursing Homes Practicing Functional Recovery Care; Case-control Study

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ABSTRACT

The world continues to struggle with the COVID-19 pandemic, and there is concern over the increase in the needs of older people for nursing care. In this study, the relationships of the “tooth condition” with mobility and cognitive function were investigated in 1,000 residents of 14 special elderly nursing homes. In those using well-fitting dentures, the percentage of those capable of independent indoor mobility was highest at 21.6%, and the percentages of those able to communicate (66.2%), understand routines (47.5%), state their own age (36.2%), remember recent events (45.0%), state their own name (85.7%), understand seasons (43.7%), and understand places (46.4%) were significantly higher than in those in other “tooth conditions”. This study clarified the relationships of the “tooth condition” with mobility and cognitive function, and maintaining an adequate “tooth condition” was suggested to contribute to the prevention of a condition requiring long-term nursing care.

Key-words: Functional recovery care, special elderly nursing homes, tooth condition, mobility, cognitive function

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I. Introduction

The world has been facing the COVID-19 pandemic since 2020, and older people, who are at a higher risk of exacerbation of infection, are considered to have an increased risk of becoming care-dependent due to the decline of physical and cognitive functions and frailty caused by a worsening nutritional state.¹⁾ We have studied “malnutrition” and increased the necessity for care and clarified causes of the lack of improvement in “malnutrition” in older people by pointing out problems including the insufficiency of awareness of workers providing long-term care insurance services,²⁾ relationship between the nutritional state and decline of physical/mental functions in older people requiring nursing care,³⁾ and the absence of nutritional education for care managers.⁴⁾ Concerning cooperation for “improving nutrition”, we proposed the necessity of organic cooperation by the standardization of assessment and utilization of ICT.⁵⁾ We further clarified the relationship between “food type” and independence of physical/mental functions in older people requiring nursing care for the realization of “nutritional improvement” in the local comprehensive care system in Japan.⁶⁾

In this study, we hypothesized that the “tooth condition”, which affects the “food type”, is related to the independence of mobility and cognitive functions of older people requiring nursing care and examined the hypothesis in the residents of special elderly nursing homes. The term “food form” indicates “regular food” or “soft food”. Among the preceding studies on oral function and physical/mental functions of older people, there have been a few studies concerning the relationships of mastication ability and occlusal force with physical/mental functions such as those on the association of mastication ability with physical functions and evaluation items of vital functions,⁷⁾ relationships of occlusal force with balance function, gait, and falling,⁸⁾ and effects of occlusal force on brain function.⁹⁾ In addition, there has been a report suggesting that loss of teeth can be a risk factor for dementia and that the edentulous jaw is related to depression.¹⁰⁾ We, therefore, conducted this study to clarify the relationships of the “tooth condition”, which affects oral functions such as masticatory strength and occlusal force, with mobility and cognitive function. This study focused on the natural teeth or fit of dentures. A special elderly nursing home is a residential facility for older people requiring nursing care that helps in bathing, excretion, eating, etc., other care in daily living, functional training, health management, and recuperative care.¹¹⁾ In this study, for validation, the “tooth condition” was classified as “retaining natural teeth”, “using well-fitting dentures”, “using poorly-fitting dentures”, and “needing but not using dentures”.

II. Subjects and Methods

1. Study and Procedures

1) Study Design

A quantitative, descriptive study.

2) Study Period

From April 1, 2019, to March 31, 2020.

3) Subjects

(1) Population of study subjects

The subjects were 1,000 residents of 14 special elderly nursing homes that participated in functional recovery care workshops with one of the authors serving as a lecturer. There were no dropouts during the investigation.

The special elderly nursing homes that participated in this study were facilities that learned theories of functional recovery care by holding an annual series of 6 training sessions in which an author was involved as a lecturer and were practicing basic functional recovery care. The special elderly nursing homes that are members of the Aichi Prefecture Council of Senior Citizens Welfare Facilities participated in the 6-session training course and practiced functional recovery care for all residents, and reported changes in their physical/mental functions using a scoring system, aiming to validate the effectiveness of the program.¹²⁾ We considered that the relationships of the “tooth condition” with the independence of mobility and cognitive functions of older people needing nursing care can be clarified by conducting this study at the special elderly nursing homes participating in the training course. The authors also used the data collected at the workshops for the evaluation of the relationships of the “food type” with mental and physical functions in a previous study.⁶⁾ Basic functional recovery care taught in the training sessions means care aiming at improvement in the independence of physical/mental functions of older people requiring nursing care, which includes “basic care” consisting of care of “hydration”, “diet”, “excretion”, and “exercise”.¹³⁾

(2) Eligibility criteria

Facilities and residents who have consented to use the data collected in the workshop. Residents whose underlying diseases have not worsened.

(3) Exclusion criteria

Facilities and residents who do not consent to this study. In addition, residents with worsening underlying diseases.

4) Study Items

(1) Basic attributes

Age, sex, necessary care level, ADL independence level of disabled older people (J: capable of walking outdoors, A: capable of walking indoors, B: dependent on a wheelchair, C: bed-bound), and ADL independence level of demented older people (I: suspected to be demented, II: observation needed, III: occasional assistance needed, IV: full-time assistance needed, M: medical care needed)

(2) Basic functional recovery care

Fluid intake/day, dietary intake/day, time spent out of bed/day, walking distance/day

(3) The tooth condition

Retaining natural teeth, using well-fitting dentures, using poorly-fitting dentures, and needing but not using dentures

(4) Mobility

Outdoor and indoor mobility and use of walking aids outdoors and indoors

(5) Cognitive function

Communication, understanding of daily routines, telling age and name, immediate memory, understanding the season, and understanding the place

5) Ethical Considerations

After obtaining consent from the workshop organizer and managers of the study facilities, research information was made available to the public by opting out to the individual and his/her family, and the principle of voluntary participation was ensured by providing subjects with the opportunity to withdraw from participation in this study. The study was approved by the Institutional Ethics Committee (approval number: 1-06).

2. Data Collection

Data regarding the study items were extracted from those submitted in May 2019 during the workshops held with one of the authors as a lecturer.

3. Data Analysis

After simple tallying, cross tabulation and the χ^2 test were performed to examine the relationships of the "tooth condition" with mobility, and cognitive function. Statistical analysis was performed using IBM SPSS Statistics 26.0, with the significance level set at $p < 0.05$.

III. Results

1. Basic Attributes (Table 1)

The subjects had a mean age of 85.9 ± 7.8 years and consisted of 227 males (22.7%) and 773 females (77.3%). Their mean necessary care level was 3.7 ± 0.99 . The ADL independence level of disabled older people was J1 in 3 (0.3%), J2 in 16 (1.6%), A1 in 94 (9.4%), A2 in 215 (21.5%), B1 in 211 (21.1%), B2 in 320 (32.0%), C1 in 51 (5.1%), and C2 in 90 (9.0%), with B2 being the highest. The ADL independence level of demented older people was independent in 14 (1.4%), I in 40 (4.0%), IIa in 60, IIb in 140 (14.0%), IIIa in 422 (42.2%), IIIb in 92 (9.2%), IV in 179 (17.9%), and M in 53 (5.3%), with B2 being the highest. with B2 being the highest.

<Table 1> Basic attributes

Age			85.9±7.8
Care grade			3.7±0.99
		n	%
Sex	Male	227	22.7
	Female	773	77.3
Level of independence based on the ADL Independence Scale for Older People with Disabilities	J1	3	0.3
	J2	16	1.6
	A1	94	9.4
	A2	215	21.5
	B1	211	21.1
	B2	320	32.0
	C1	51	5.1
Level of independence based on the ADL Independence Scale for Older People with Dementia	C2	90	9.0
	Independent	14	1.4
	I	40	4.0
	II a	60	6.0
	II b	140	14.0
	III a	422	42.2
	III b	92	9.2
IV	179	17.9	
M	53	5.3	

2. Basic functional recovery care (Table 2)

In the subjects receiving basic functional recovery care, the mean fluid intake/day was 392.9±381.2 ml, dietary intake/day was 1,361.6±272.4 kcal, time spent out of bed/day was 630.3±231.7 min, and walking distance/day was 118.4±280.4 m.

<Table 2> Basic functional recovery care

	n	Min	Max	Ave	SD
Fluid intake/day (mL)	997	50	3103	1393	381.2
Dietary intake/day (kcal)	1000	30	2300	1362	272.4
Time spent out of bed/day (minutes)	998	0	1080	630.3	231.7
Walking distance/day (m)	1000	0	5338	118.4	280.4

3. Tooth condition (Table 3)

The tooth condition was retaining natural teeth in 347 (34.7%), using well-fitting dentures in 453 (45.3%), using poorly-fitting dentures in 55 (5.5%), and needing but not using dentures in 145 (14.5%): those using well-fitting dentures accounted for the highest percentage.

<Table 3> Tooth condition

	n	%
Natural teeth	347	34.7
Well-fitting dentures	453	45.3
Poorly-fitting dentures	55	5.5
Needing but not using dentures	145	14.5

4. Relationship between tooth condition and mobility (Table 4)

Regarding the tooth condition and indoor mobility, 68 (19.6%) of those retaining natural teeth had independent mobility, 61 (17.6%) needed observation, 44 (12.7%) needed partial assistance, 172 (49.6%) needed total assistance, and 2 (0.6%) were not evaluated; 98 (21.6%) of those using well-fitting dentures had independent mobility, 86 (19.0%) needed observation, 114(25.2%) needed partial assistance, 151(33.3%) needed total assistance, and 4 (0.9%) were not evaluated; 6 (10.9%) of those using poorly-fitting dentures showed independent mobility, 15 (27.3%) needed observation, 7 (12.7%) needed partial assistance, 27 (49.1%) needed total assistance, and 0 (0.0%) were not evaluated; 21 (14.5%) of those needing but not using dentures had independent mobility, 16 (11.0%) needed observation, 20 (13.8%) needed partial assistance, 87 (60.0%) needed total assistance, and 1 (0.7%) was not evaluated. A significantly higher percentage of those using

well-fitting dentures were independent in indoor mobility compared with those retaining natural teeth, those using poorly-fitting dentures, and those needing but not using dentures.

Regarding the tooth condition and outdoor mobility, 7 (2.0%) of those retaining natural teeth showed independent mobility, 25 (7.2%) needed observation, 24 (6.9%) needed partial assistance, 145 (41.8%) needed total assistance, and 146 (42.1%) were not evaluated; 12 (2.6%) of those using well-fitting dentures had independent mobility, 43 (9.5%) needed observation, 33 (7.3%) needed partial assistance, 186 (45.5%) needed total assistance, and 179 (38.2%) were not evaluated; 3 (5.5%) of those using poorly-fitting dentures showed independent mobility, 2 (3.6%) needed observation, 4 (7.3%) needed partial assistance, 25 (45.5%) needed total assistance, and 21 (38.2%) were not evaluated; 4 (2.8%) of those needing but not using dentures showed independent mobility, 2 (8.3%) needed observation, 6 (4.1%) needed partial assistance, 75 (51.7%) needed total assistance, and 48 (33.1%) were not evaluated. No significant difference was noted in these results.

<Table 4> Relationship between tooth condition and mobility

		Tooth condition								P-value
		Natural teeth		Well-fitting dentures		Poorly-fitting dentures		Needing but not using dentures		
		n	%	n	%	n	%	n	%	
Indoor mobility	Independent	68	19.6	98	21.6	6	10.9	21	14.5	<0.001 **
	Requiring observation	61	17.6	86	19.0	15	27.3	16	11.0	
	Partial assistance	44	12.7	114	25.2	7	12.7	20	13.8	
	Full assistance	172	49.6	151	33.3	27	49.1	87	60.0	
	Unable to move	2	0.6	4	0.9	0	0.0	1	0.7	
Outdoor mobility	Independent	7	2.0	12	2.6	3	5.5	4	2.8	0.454
	Requiring observation	25	7.2	43	9.5	2	3.6	12	8.3	
	Partial assistance	24	6.9	33	7.3	4	7.3	6	4.1	
	Full assistance	145	41.8	186	45.5	25	45.5	75	51.7	
	Unable to move	146	42.1	179	38.2	21	38.2	48	33.1	

chi-square test, *: P<0.05, **: P<0.01

5. Relationship between tooth condition and cognitive function (Table 5)

Regarding the tooth condition and communication, communication was “possible” in 167 (48.1%) of those retaining natural teeth, “occasionally possible” in 82 (23.6%), “nearly impossible” in 30 (8.6%), and “impossible” in 68 (19.6%); possible in 300 (66.2%) of those using well-fitting dentures, “occasionally possible” in 91 (20.1%), “nearly impossible” in 32 (7.1%), and “impossible” in 30 (6.6%); “possible” in 26 (47.3%) of those using poorly-fitting dentures, “occasionally possible” in 14 (25.5%), “nearly impossible” in 5 (9.1%), and “impossible” in 10 (18.2%); and “possible” in 59 (40.7%) of those needing but not using dentures, “occasionally possible” in 40 (27.6%), “nearly impossible” in 17 (11.7%), and “impossible” in 29 (20.0%). The percentage of those in whom communication was “possible” was significantly higher in those using well-fitting dentures compared with those retaining natural teeth, those using poorly-fitting dentures, or those needing but not using dentures.

Regarding the tooth condition and understanding of the situation, 121 (34.9%) of those retaining natural teeth could understand the daily routine, 92 (26.5%) could tell the age, 122 (35.2%) could understand the immediately preceding event, 243 (70.0%) could tell their names, 106 (30.5%) could understand the present season, and 126 (36.3%) could understand where they were; 215 (47.5%) of those using well-fitting dentures could understand the daily routine, 92 (36.2%) could tell the age, 204 (45.0%) could understand the immediately preceding event, 388 (85.7%) could tell their names, 198 (43.7%) could understand the present season, and 210 (46.4%) could understand where they were; 20 (36.4%) of those using poorly-fitting dentures could understand the daily routine, 20 (36.4%) could tell the age, 24 (43.6%) could understand the immediately preceding event, 39 (70.9%) could tell their names, 22 (40.0%) could understand the present season, and 24 (43.6%) could understand where they were; 35 (24.1%) of those needing but not using dentures could understand the daily routine, 23 (15.9%) could tell the age, 38 (26.2%) could understand the immediately preceding event, 85 (58.6%) could tell their names, 31 (21.4%) could understand the present season, and 41 (28.3%) could understand where they were. The percentage of those who “could” understand the situation was significantly higher in those using well-fitting dentures compared with those retaining natural teeth, those using poorly-fitting dentures, or those needing but not using dentures.

<Table5> Relationship between tooth condition and cognitive function

		Tooth condition								P-value
		Natural teeth		Well-fitting dentures		Poorly-fitting dentures		Needing but not using dentures		
		n	%	n	%	n	%	n	%	
Ability to communicate	Always able	167	48.1	300	66.2	26	47.3	59	40.7	<0.001 **
	Sometimes able	82	23.6	91	20.1	14	25.5	40	27.6	
	Hardly able	30	8.6	32	7.1	5	9.1	17	11.7	
	Unable	68	19.6	30	6.6	10	18.2	29	20.0	
Understanding routines	Able	121	34.9	215	47.5	20	36.4	35	24.1	<0.001 **
Stating one's own age	Able	92	26.5	164	36.2	20	36.4	23	15.9	<0.001 **
Remembering recent events	Able	122	35.2	204	45.0	24	43.6	38	26.2	<0.001 **
Stating one's own name	Able	243	70.0	388	85.7	39	70.9	85	58.6	<0.001 **
Understanding seasons	Able	106	30.5	198	43.7	22	40.0	31	21.4	<0.001 **
Understanding places	Able	126	36.3	210	46.4	24	43.6	41	28.3	<0.001 **

chi-square test, *: P<0.05, **: P<0.01

IV. Discussion

1. Basic attributes and functional recovery care

At the 14 special elderly nursing homes that participated in this study, theories of functional recovery care are learned, and basic functional recovery care is practiced for all residents. According to the data of the Ministry of Health, Labour and Welfare in October 2019, there were 10,502 special elderly nursing homes in Japan, service was provided to 619,600 persons, and their mean necessary care level was 3.95.¹⁴⁾ Since the mean necessary care level was 3.7±0.99 in the facilities that participated in this study, their residents are considered to have been more independent than the national average. The implementation of functional recovery care shown in Table 2 is considered to be a factor of these results. Functional recovery care provided at these nursing homes is called

theory-based scientific care in Japan, and it is entitled to compensation by the newly established addition to the scientific care promotion system at the 2021 revision of payments for nursing care services.¹⁵⁾ Takeuchi, the advocator of the theory of functional recovery care, observes, “There are 4 basic cares for older people, and most activities of daily living (ADL) can be made more independent by faithfully performing these cares.”¹³⁾

2. Relationship between the “tooth condition” and mobility

Regarding the relationship between the “tooth condition” and mobility, the percentage of those independent in indoor mobility was higher in those using well-fitting dentures compared with those retaining natural teeth, those using poorly-fitting dentures, or those needing but not using dentures. Previous studies suggested the effects of the use of dentures on the body position and walking speed in older people,¹⁶⁾ its relationships with occlusal force, balance function, and mobility,¹⁷⁾ and its strong relationship with static balance including the head support and balance function.¹⁸⁾ The results of this study also suggest that occlusal force maintained by the use of well-fitting dentures improves the body position and balance, which contribute to the independence of mobility, and indicate the relationship between the “tooth condition” and mobility.

3. Relationship between the “tooth condition” and cognitive function

Regarding the relationship between the “tooth condition” and cognitive function, the percentages of those who were “able” to communicate and understand the situation were higher in those using well-fitting dentures compared with those retaining natural teeth, those using poorly-fitting dentures, or those needing but not using dentures. A study of the effects of mastication on brain functions by comparison between using and not using dentures reported that the use of dentures that provide an appropriate occlusal contact area and ensure sufficient occlusal force promotes recovery of masticatory strength, increases sensory information from the periodontal membrane, masticatory muscles, and temporomandibular joint, and activates brain functions.⁹⁾ Also, Takeuchi, who regards denture adjustment as “a new method for functional recovery care”, observed that the use of dentures made well-fitting by denture adjustment activates gait and overall brain activities, raises the arousal level of the brain, and improves the cognitive level.¹⁹⁾ Furthermore, significant correlations of occlusal force with cognitive items of the Functional Independence Measure (FIM) have been reported.²⁰⁾ The results of this study also suggest that maintenance of masticatory strength and occlusal force by the use of well-fitting dentures contributes to activation of brain functions and indicate the relationship between the “tooth condition” and cognitive function.

4. Good denture fit and mental and physical independence

These results of this study do not contradict many previous studies on masticatory strength, occlusal force, and physical/mental functions of older people, clarified the the

relationships of the “tooth condition” with mobility and cognitive function of older people requiring care, and validated the hypothesis of this study. In addition, those using well-fitting dentures were suggested to be most independent. The finding that those using well-fitting dentures were mentally and physically more independent than those retaining natural teeth is considered to be related to the number of remaining natural teeth. When the efficiency of mastication in people with normal dentition is defined as 100%, it decreases to about half by the loss of one tooth and to about 30% by the loss of multiple teeth.²¹⁾ It has also been reported that occlusal force is positively correlated to the number of remaining teeth and that occlusal force is higher as more natural teeth are retained.⁸⁾ Users of well-fitting dentures are suggested to have higher independence of mobility and cognitive functions than those with natural dentition with defects because of higher masticatory strength and occlusal force. In addition, Takeuchi, who advocated the functional recovery care theory, reported activation of mastication by denture adjustment.¹⁹⁾ It is also suggested that, in users of well-fitting dentures, mastication is activated by denture adjustment, and an adequate nutritional condition is maintained by intake of a regular diet. According to our study, a regular diet was closely correlated with the serum albumin (Alb) level, which is an index of nutritional condition.²²⁾ A study of the use of dentures in older edentulous patients also showed age-associated decreases in the percentages of those eating a regular diet and denture users with a decline in nutritional state and suggested that dentures play an important role in the maintenance of an adequate nutritional state.²³⁾ There is also a study that indicated the relationships of the number of remaining teeth, occlusal support, and use or no use of dentures with the nutritional state.¹⁹⁾ Adequate fitting of dentures is considered to be related to a good nutritional state through activation of mastication and occlusal support. The nutritional state must be maintained at a reasonable level for the prevention of frailty, which is a risk factor for care-dependency. Maintaining an adequate “tooth condition” was suggested to contribute to the prevention of a condition requiring long-term nursing.

5. Limitations and conclusion of this study

This study suggests that the "dental condition" of older people requiring nursing care has the highest degree of autonomy in mobility and cognitive function with well-fitting dentures. However, the number of remaining teeth was not investigated in this study, and the theme remains to be addressed in future studies.

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