The Relationships Between Masticatory Ability and Locomotive Syndrome of the Elderly Aged 65-74

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To clarify the relationships between the masticatory ability and the locomotive syndrome, we, a research team, evaluated simultaneously the degree of locomotive syndrome, for which "The 25-question Geriatric Locomotive Function Scale（Locomo 25），" a rough-diagnosis tool for locomotive syndrome was used, and three indexes concerning the masticatory ability; the objective masticatory ability index, the subjective masticatory ability index, and the number of teeth. The research was aimed at the younger elderly aged 65-74, who took the town's Specific Medical Examination. Even with adjustments of the confounding factors, a significantly large number of participants with lower masticatory ability had the locomotive syndrome.

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INTRODUCTION

Expanding the health spans of the elderly aged 75 and over by preventing their possible frailties from progressing has been one of the common purposes among the health, medical and welfare fields. The frailties are largely divided into physical, mental and psychological, and social ones. The physical frailty mainly results in sarcopenia, the loss of skeletal muscle mass with age, as well as locomotive syndrome that causes the functional decline of the whole locomotory apparatus. Moreover, the oral frailty, or the deterioration of oral function, undernutrition, cognitive function decrease, and the control of chronic diseases interactively connect with the progression of the frailties [1].

The 25-question Geriatric Locomotive Function Scale（Locomo 25）is designed to draw the result from a score from 0 to 100 in total, with the response to 25 questions, which have the five-grade choices from 0 to 4, relating to the functions of locomotory apparatus [2]. It has been developed to evaluate locomotory disorders in a quantitative way. Using paper to reply to the questions, Locomo 25 does not so much depend on the places and the operation skill of the researchers. With the easiness of use and its statistical adequacy, Locomo 25 is also convenient when applied to various possible clinical situations.

For the relationships between the oral function,

which focuses on the masticatory ability, and the whole health condition, we have carried out the dental and oral health examination, aiming at those who are the examinees of the Specific Medical Examination by Ohnan Town. Currently, we have reported the analysis of the connections of the oral function with nutrition intake [3], metabolic syndrome [4], cognitive function [5, 6] and feeding behavior [7].

A report regarding the relationships between the number of lost teeth with the physical function and the sense of balance [8] can be found, but there seems to be no reports of the relationships of the oral function focusing on the masticatory ability and Locomo 25, which is proper for the applications in clinical scenes. Thus, we aimed to investigate whether oral health status including remaining teeth and masticatory ability is associated with locomotive syndrome among the elderly aged 65-74, who took the Specific Medical Examination by Ohnan Town in 2015. We assessed the dental and oral health condition and an examination with Locomo 25, for the participants of the Specific Medical Examination by Ohnan Town, and conducted to analyze using a cross-sectoral design.

MATERIALS AND METHODS

Setting and participants

This study was part of the Shimane CoHRE study. The Shimane CoHRE study was conducted by Shimane University in collaboration with the annual health examination program that involved the population of Ohnan Town of Shimane Prefecture in Japan between June and July 2015. Specific Medical Examination are available once a year for residents in this municipality who are 40 to 74 years of age and covered by National Health Insurance. Data was obtained from 498 participants in this study.

The study protocol was approved by the Ethics Committee of Shimane University (No. 1821), and written informed consent was obtained from all study subjects prior to the study.

Assessment

In addition to the regular physical examination, we made examinations using "Locomo 25," "Cognitive Assessment for Dementia, iPad version (CADi)", and "Self-Rating Depression Scale (SDS)", and also researched the walking speed, grip strength, years of education and other medical treatments. Moreover, in the dental section, dental hygienists led the dental and oral health research; the objective and subjective mastication abilities and the number of teeth. The objective mastication ability was tested in the following way. The examinees tried to chew gummy jelly (Fine-gumi®) for 15 seconds, and after that the researchers measured the number of the pieces whose size was 3mm or larger, which is called the "Gummy 15-Second Value." The subjective mastication ability was evaluated through a questionnaire asking whether the examinee has something he/she could chew.

Statistical analyses

We regarded the participants who had the Locomo 25 score of 16 or more as the "suspected locomotive syndrome (Suspected Locomo)" group [2]. For the mastication abilities, we divided the participants into three indexes; the index of the objective mastication ability, that of the subjective mastication ability and that of the number of teeth. For the objective mastication ability index, based on the number of pieces measured by the Gummy 15-second Value, we divided the participants into four groups; 1-8 Pieces, 9-19 Pieces, 20-30 Pieces, and 31 or More Pieces. For the subjective index, two groups were made; the "Can Chew" group and the "Cannot Chew" group. For the number of teeth, the participants were divided into five groups; 0 Teeth, 1-9 Teeth, 10-19 Teeth, 20-27 Teeth, and 28 or More Teeth.

The subject of the walking speed [9] was divided into two groups; "1.0 m/sec and More" and "Less than 1.0 m/sec." That of the grip strength [9] was divided into two groups; "Decreased" for males with less than 25 kg and females with less than 20 kg, and "Normal" for males with 25 kg or more and females with 20 kg or more. For the Cognitive function [10], those who had the CADi score of 6 or less, or those who operate the CADi for 200 seconds or more were regarded as the group of "Suspected Cognitive Function Decrease," and the others were as the "Non-Suspectable" group. Those who had the SDS score of 40 or more were as-

signed to the group of "Near Depression," the others who had the score of less than 40 were assigned to the "Normal" group. For sleeping to rest themselves, which is one of the subjects of the Specific Medical Examination, we divided the participants into two groups; "Good Sleeping" for those who could get rest by sleeping, and "Non-Good Sleeping" for those who could not get rest by sleeping.

The years of education was divided into two groups; a group for those who have been educated for "Less than 10 Years", and a group for those who have been educated for "10 Years or More." For other medical treatments, we divided the participants into two groups; "No Treatment" and "Under Treatment." After making a cross tabulation with "Suspected Locomo" and "Non-Suspectable" as headers, we established a logistic regression analysis model, in which we input the three indexes of the mastication ability as predictor variables, setting "Suspected Locomo" and "Non-Suspectable" as the objective variables. The basis of the dummy variables for the three indexes were: the "31 or More Pieces" group for the objective mastication ability index, the "Can Chew" group for the subjective mastication ability index, and the "28 or More Teeth" for the number of teeth. Then we input these dummy variables separately into the model.

We regard the result by adding no attributes as Model 1, and the result from the additional input of the basic attributes (age, sex, BMI) as Model 2, and the result from the additional input of items that were significant (p < 0.05) in the cross tabulation as Model 3. In the series of the statistical analysis, we used STATA14.2CI as a software for statistical analysis, and regarded p < 0.05 as the significance level.

RESULTS

The subjects were the elderly aged 65-74, who took the Specific Medical Examination by Ohnan Town in 2015 and visited the dental section. Out of 513 people in total, we analyzed 498 people after a list-wise case deletion. The sex ratio was 43% male and 57% female, and the average age was 69.9 ± 2.8.

The result of the cross tabulation under the head-ing of "Suspected Locomo" and "Non-Suspectable" is shown in Table 1. Only the items of p < 0.05 except the basic attribute are represented.

The number of participants in "Suspected Locomo" was 78 out of 498 (15.7%). In the cross tabulation, the features of the "Suspected Locomo" are: the average age was higher, more of the suspected had less teeth, more of them belonged to the "Cannot Chew" group in the subjective mastication ability index, and the partition number in the objective mastication ability index was smaller. Other groups to which a significantly larger number of the applicable belonged were: "Non-Good Sleeping," "Near Depression," "Less than 10 years" for education, "Less than 1.0 m/s" for the walking speed, "Decreased" for the grip strength, "Under treatment" for hyperuricemia, "Under treatment" for bone and joint disease, and "Suspected Cognitive Function Decrease" in the cognitive function.

Table 2 shows the result of the logistic regression analysis, the relationships between the three indexes of the masticatory ability; the objective/subjective indexes and the number of teeth, and the Suspected Locomo/Non-Suspected Locomo. In Model 1, in which only the objective index, the subjective index and the number of teeth were separately input, the odds ratio (95% CI) given to the objective index were: 3.87 (1.69-8.85) to "1-8 Pieces", and 2.38 (1.00-5.65) to "9-19 Pieces." These had "31 or More" as the base. That of "Cannot Chew" of the subjective index was 2.11 (1.29-3.46) with "Can Chew" as the base. That of "0 Teeth" was 3.29 (1.27-8.5), "0-9 Teeth" 3.84 (1.58-9.38), "10-19 Teeth" 3.04 (1.27-7.27) and "20-27 Teeth" 2.26 (1.02-4.99) with "28 or More Teeth" as the base.

In Model 2, in which the basic attributes (age, sex, BMI) were additionally input to Model 1, the odds ratios (95% CI) to the objective variable were: 3.58 (1.54-8.28)to "1-8 Pieces" of the objective index with "31 or More Pieces" as the base, 2.27 (1.37-3.77)to "Cannot Chew" of the subjective index with "Can Chew" as the base. In regards to the number of teeth, 2.74 (1.04-7.19) to "0 Teeth", 3.25 (1.31-8.07) to "1-9 Teeth," 2.61 (1.08-6.31) to "10-19 Teeth," whose basis were "28 or More Teeth."

In Model 3, in which variables meeting a condi-

Table 1. The cross tabulation under the Heading of "Suspected Locomo" and "Non-Suspectable Locomo"

		Headcour	Non-Suspectible	Suspected	p value
		498	420(84.3)	78(15.7)	
Age＊		498	69.7(2.8)	70.7(2.7)	0.006
Sex	Male	215	184(85.6)	31(14.4)	0.506
	Female	283	236(83.4)	47(16.6)	
BMI	Less than 18.5	31	26(83.9)	5(16.1)	
	18.5 - 24	374	322(86.1)	52(13.9)	0.119
	25 or More	93	72(77.4)	21(22.6)	
Number of Teeth	0 Teeth	53	42(79.3)	11(20.8)	
	1-9 Teeth	64	49(76.6)	15(23.4)	
	10-19 Teeth	82	66(80.5)	16(19.5)	0.024
	20-27 Teeth	177	150(84.8)	27(15.3)	
	28 or More Teeth	122	113(92.6)	9(7.4)	
Mastication	Subjective Index — Cannot Chew	152	117(78.0)	35(23.0)	0.003
	Subjective Index — Can Chew	346	303(87.6)	43(12.4)	
	Objective Index Gummy 15-Second Value Quartile — 1-8 Pieces	127	97(76.4)	30(23.6)	
	9-19 Pieces	125	105(84.0)	20(16.0)	0.008
	20-30 Pieces	138	118(85.5)	20(14.5)	
	31 or More Pieces	108	100(92.6)	8(7.4)	
Sleeping Quality	Good	377	333(88.3)	44(11.7)	< 0.001
	Non-Good	121	87(71.9)	34(28.1)	
Self-Evaluated Depression Scale	Normal	397	353(88.9)	44(11.1)	< 0.001
	Near Depression	101	67(66.3)	34(33.7)	
Educational Year	10 or More Years	348	304(87.4)	44(12.6)	0.005
	Less than 10 Years	150	116(77.3)	34(22.7)	
Walking Speed	1.0 or More m/sec	471	405(86.0)	66(14.0)	< 0.001
	Less than 1.0m/sec	27	15(55.6)	12(44.4)	
Grip Strength	Normal	465	403(86.7)	62(13.3)	< 0.001
	Decreased	33	17(51.5)	16(48.5)	
Hyperuricemia	No Treatment	482	410(85.1)	72(14.9)	0.015
	Under Treatment	16	10(62.5)	6(37.5)	
Bone and Joint Disease	No Treatment	395	350(88.6)	45(11.4)	< 0.001
	Under Treatment	103	70(68.0)	33(32.0)	
Cognitive Function	Normal	475	405(85.3)	70(14.7)	0.010
	Suspected Function Decrease	23	15(65.2)	8(34.8)	

Note1: Near depression; 40 or more on Self-Rating Depression Scale (SDS) / Normal; less than 40

Note2: Decreased grip strength; less than 25kg (males) and less than 20kg (females)/ Normal; 25kg or more (males) and 20kg or more (females)

Note3: Suspected Cognitive Function Decrease CADi score 6 or less or 200sec or more to operate CADi /Normal; Non-Appricable

Note4: We regarded "can chew anything" as "Can Chew", "have something I cannot chew" as "Cannot Chew" in the questionare.

Note5: t-test was conducted only for age＊ to represent the average value, the standard deviation. χ2-test was conducted for the others to represent the headcount in percentage.

Table 2. The relationship between the Three Indexes of the Masticatory Ability and the Suspected/Non-Suspected Locomo by Logistic Regression Analysis

			Model 1			Model 2			Model 3		
		headcount	Odds	95% CI	p value	Odds	95% CI	p value	Odds	95% CI	p value
3 Indexes of the Masticatory Ability	Number of Teeth — 0 Teeth	53	**3.29**	**1.27 8.50**	**0.014**	**2.74**	**1.04 7.19**	**0.041**	2.03	0.64 6.38	0.224
	1-9 Teeth	64	**3.84**	**1.58 9.38**	**0.003**	**3.25**	**1.31 8.07**	**0.011**	**3.18**	**1.13 8.94**	**0.028**
	10-19 Teeth	82	**3.04**	**1.27 7.27**	**0.012**	**2.61**	**1.08 6.31**	**0.033**	**3.01**	**1.11 8.17**	**0.031**
	20-27 Teeth	177	**2.26**	**1.02 4.99**	**0.044**	2.10	0.94 4.66	0.069	2.20	0.89 5.43	0.086
	28 or More Teeth	122	1.00	ref		1.00	ref		1.00	ref	
	Subjective Index — Cannot Chew	152	**2.11**	**1.29 3.46**	**0.003**	**2.27**	**1.37 3.77**	**0.001**	**1.92**	**1.08 3.43**	**0.026**
	Can Chew	346	1.00	ref		1.00	ref		1.00	ref	
	Objective Index Gummy 15-second Value Quartile — 1-8 Pieces	127	**3.87**	**1.69 8.85**	**0.001**	**3.58**	**1.54 8.28**	**0.003**	**3.38**	**1.32 8.69**	**0.011**
	9-19 Pieces	125	**2.38**	**1.00 5.65**	**0.049**	2.19	0.91 5.24	0.079	1.95	0.75 5.11	0.174
	20-30 Pieces	138	2.12	0.89 5.02	0.088	2.08	0.87 4.97	0.101	2.06	0.80 5.28	0.133
	31 or More Pieces	108	1.00	ref		1.00	ref		1.00	ref	

Model 1: adding no attributes

Model 2: adding the basic attributes (age, sex, BMI)

Model 3: adding cognitive function, bone and joint disease, hyperuricemia, grip strength, walking speed, educational year, depression scale, and quality of sleeping to Model 2

tion of p $<$ 00.05 in the cross tabulation were additionally input to Model 2, the odds ratios (95% CI) to the objective variables were: 3.38(1.32-8.69) to "1-8 Pieces" of the objective index with "31 or More Pieces" as the base, 1.92 (1.08-3.43) to "Cannot Chew" of the subjective index with "Can Chew" as the base. Those under "1-9 Teeth" was 3.18(1.13-8.94), and "10-19 Teeth" 3.01(1.11-8.17) with "28 or More Teeth" as the base. The research team confirmed the possibility of the multicollinearity among the predictor variables in Model 3, by estimating Variance Inflation Factor (VIF). As a result, no values beyond 1.8 were found.

DISCUSSION

We applied Locomo 25, which has been developed for easier diagnosis of locomotive syndrome, to those who took the Specific Medical Examination, and extracted the "Suspected Locomo" group. Out of the subjects for the analysis, 15.7% were "Suspected Locomo." It is generally said that 21% [2] of the elderly who are aged 65 or more and require no care, whose average age is 77, are suspected as Locomo. Considering that the subjects for this research were all the elderly aged 65-74 and the average age was 70, the result seems to be appropriate.

It is reported that depression [11] and cognitive function [12] decrease have some relationships with locomotive syndrome or certain symptoms concerning Locomo 25. In addition, age, grip strength, walking speed and treatment status for bone and joint disease were extracted as factors with significant relationships with locomo in this research. This seems to have the rationality, taking account of the clinical conditions of locomotive syndrome. And we have reported the grip strength, the walking speed [13] and the cognitive function [5, 6] as indexes concerning the masticatory ability. As Model 3 shows, even after the adjustment with confounding factors, the significant relationships between Suspected Locomo/Non-Suspectable and the three indexes of the masticatory ability have been taken over. That suggests that many of those who have less masticatory ability are significantly included in the Suspected Locomo.

Considering that the research was cross-sectional,

we cannot dissertate about the causality. This fact, however, resulted in those who had the progression of locomotive syndrome also had a decrease of the masticatory ability. Locomotive syndrome, frailties and sarcopenia are part of the clinical conditions which occur with advancing age, causing the multiple decrease of the bodily function. In this research, we clarified that the decrease of the masticatory ability is also part of those. Considering that the decreased functions are caused by multiple ways and the proper intervention in frailties would help functional recovery and maintenance, the cooperation between the medical and dental fields would result in the possibility of synergistic effects.

CONCLUSION

Our study found that a low level of objective-assessed masticatory ability was associated with suspected locomotive syndrome among the elderly. In addition, a decline in the number of remaining teeth and subjective-assessed masticatory dysfunction was associated with suspected locomotive syndrome. These findings suggest that maintenance of dental and oral health condition may prevent locomotive syndrome. Future longitudinal studies should be designed to investigate the association between oral health and locomotive syndrome.

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