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Original Article

Relationship between oral hygiene and function and activities of daily living at discharge in convalescent patients with stroke

Kana Oishi, DH,[1] Shinta Nishioka, PhD, RD,[2] Yuka Okazaki, ST,[1] Kozue Hirakawa, Ns,[1] Mimoka Nakamura, DH,[1] Ai Ichinose, DH,[1] Masaki Kurihara, MD, PhD[3]

[1]Clinical Department, Nagasaki Rehabilitation Hospital, Nagasaki, Japan
[2]Nutrition Management Office, Nagasaki Rehabilitation Hospital, Nagasaki, Japan
[3]Nagasaki Rehabilitation Hospital, Nagasaki, Japan

ABSTRACT
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Objective: This study was designed to examine the relationship between improvement in oral hygiene and function and activities of daily living (ADLs) at discharge in patients admitted to convalescent rehabilitation wards.
Methods: Eligible criteria were patients with stroke with a score of 13 or higher (i.e., severe oral problems) on the Revised Oral Assessment Guide (ROAG) at admission. Age, gender, primary diseases, rehabilitation dose, dentist visits and denture status, Eichner classification, eating status at admission and discharge, and body mass index at admission were collected. The patients were classified into two groups: those with ROAG scores of less than 9 points at discharge (good ROAG group) and those with scores of 9 points or more (poor ROAG group), and Functional Independence Measure (FIM) gain and total FIM discharge scores were compared using univariate and multivariate analyses.
Results: The good and poor ROAG groups comprised 126 and 366 patients, respectively. The good ROAG group had significantly higher total FIM score, FIM efficiency, and FIM gain at discharge than the poor ROAG group (112 vs. 82; $P < 0.001$). The ROAG scores at discharge were independently associated with FIM gain (partial regression coefficient = −9.889, 95% confidence interval = −13.499 to −6.279) and total FIM score at discharge.
Conclusion: Improvement in oral hygiene and function in convalescent patients with stroke was associated with ADLs at hospital discharge.
Key words: Kaifukuki (convalescent) rehabilitation ward, stroke, oral status, ADL at discharge

Introduction

Older adults and individuals who require nursing care often have poor oral hygiene and oral dysfunction, leading to an increased incidence of aspiration pneumonia and mortality [1–3]. Moreover, this is evident in patients with stroke, among whom 78% have dysphagia and loss of oral sensation, leading to the stagnation of saliva and food in the mouth [4]. In contrast, good oral health, including the use of dentures, was associated with a lower risk of developing care needs [5–6], and the implementation of oral care reduced the incidence of pneumonia by approximately 40% [7]. Furthermore, a study has reported that the introduction of a comprehensive oral care program to patients with stroke reduced hospitalization-related pneumonia [8]. Thus, assessing and improving oral hygiene and function is essential.

Furthermore, oral management in patients admitted to a Kaifukuki (convalescent) rehabilitation ward may improve outcomes, such as discharge to home and improvement of activities of daily living (ADLs) [9]. An analysis using a multicenter database has shown that patients admitted to Kaifukuki rehabilitation wards with full-time dental hygienists had better ADLs and swallowing ability at discharge than those in wards without dental hygienists [10]. Thus, dentists and dental hygienists may contribute to preventing pneumonia and improving eating-related ADLs in patients with stroke by improving oral hygiene, oral functions, chewing and swallowing functions, and nutritional status.

However, there are few reports examining the

Correspondence: Kana Oishi, DH
Nagasaki Rehabilitation Hospital, 4–11, Ginya-machi, Nagasaki, Nagasaki 850–0854, Japan.
E-mail: dh-reha@zeshinkai.or.jp
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association between improvement in oral status and ADL recovery in individuals requiring nursing care and convalescent patients with stroke. As mentioned earlier, some studies have verified the effectiveness of oral care in preventing pneumonia in patients with stroke [4] and the roles of dental hygienists in improving ADLs [10]; however, the question as to whether the improvement of oral hygiene and function by the intervention of dental hygienists and others contributes to improving ADLs has not yet been answered.

Therefore, this study was designed to clarify the relationship between oral hygiene and function and the improvement of ADLs in patients with stroke admitted to Kaifukuki rehabilitation wards.

Methods

A cross-sectional study was conducted to examine the relationship between the degree of improvement in oral hygiene and function as assessed using the Revised Oral Assessment Guide (ROAG) (Table 1) and the Functional Independence Measure (FIM) and activities of living at hospital discharge in patients with stroke. The primary outcome was FIM gain, and the secondary outcome was the total FIM score at discharge.

1. Target

Of the 1,018 patients newly admitted and discharged to Hospital A for post-stroke rehabilitation between January 1, 2018 and December 31, 2020, 641 (63.0%)

Table 1. Revised oral assessment guide (ROAG) [12–14].

Item	Method	State and score		
		1	2	3
Voice	Conversation with patient	Normal	Low or faint	Difficulty talking or painful
Swallowing	Encouragement and observation of swallowing	Normal swallowing	Painful or difficulty on swallowing	Unable to swallow
Lips	Observation and palpation of tissue	Smooth and pink	Dry or fissure and/or angular inflammation of the mouth	Ulcerated or bleeding
Teeth and dentures	Observation of the condition of the teeth and the fit of the denture using a penlight and mirror	Clean and free of food residue	(1) Partial plaque and food residue (2) Caries and denture damage	Overall plaque and food residue
Mucous membrane	Observation of the condition of the mucous membrane using a penlight and mirror	Pink and moist	Dry and/or change in color to red, purple, or white	Pronounced reddening of the skin or thick tongue moss, blisters, and ulcers with or without bleeding
Gum	Visual and finger palpation using a penlight and mirror	Pink and firm	Edematous and/or redness	Bleeds easily with finger pressure
Tongue	Visual examination using a penlight and mirror	Pink and moist with papillae	Dryness, loss of papillae, or change to red or white	Very thick tongue blisters and ulcers
Saliva	Visual examination using a penlight and mirror	No friction between the mirror and mucosa	Slightly increased friction, but the mirror does not tend to stick to the mucosa	Significantly increased friction and the mirror sticks to the mucosa or sticks together

From the total ROAG score, 8 points is classified as no problem, 9–12 points as mild to moderate problem, and 13–24 points as severe problem.

were assessed as having a total ROAG score of 13 or higher (severe problem) on admission. Among them, 140 who were discharged to an acute care hospital, three who died, two who were transferred to other Kaifukuki rehabilitation wards, and three who were ineligible for the study because their hospital stay exceeded 180 days were excluded; thus, 492 patients were included in this study.

2. Data collection

Age, gender, primary disease, length of stay, discharge destination, rehabilitation dose, dentist visits, dentures, Eichner's classification, level of eating status at admission and discharge (Food Intake Level Scale (FILS)) (Table 2) [11], and body mass index (BMI) at admission were investigated.

3. Assessment of oral health

Three dental hygienists dedicated to the ward with 3−15 years of experience assessed the ROAG scores on admission and at discharge. Of them, a dental hygienist with 15 years of experience and proficiency in ROAG instructed the other two dental hygienists in ROAG, and a pretest was conducted for 1 month to ensure that there were no discrepancies between the dentists. The ROAG is a simple and objective tool for assessing oral hygiene and function [12−14] and consists of eight items. Based on the ROAG total score, scores of 8 points were classified as no problem, scores of 9−12 points were classified as mild to moderate problem, and scores of 13−24 points were classified as severe problem. The ROAG was developed for older adults and has shown good reliability. The assessment of the ROAG scores during admission was conducted on the first day of hospitalization before meals and oral care were provided. Discharge assessments were conducted within 3 days of the date of discharge from the hospital. The dental hygienists assessed all hospitalized patients once a month for oral assessment and planning, and intervened in oral hygiene, oral function, and diet, among others, by setting a level of independence for each patient. The oral care methods assessed and reviewed by the dental hygienists were instructed to nurses, care workers, and speech-language-hearing therapists through direct intervention guidance and verbal instruction. Actual oral care was provided by a nurse or care worker at least three times a day, after each meal.

4. ADL assessment

ADL was assessed within 3 days of admission and on the day of discharge, mainly by nurses and care workers using the FIM. At Hospital A, all healthcare professionals had attended in-house training to accurately assess patients using the FIM. The primary evaluation of the

Table 2. Food intake level scale [11].

Some problems suggest feeding and swallowing disorders	No oral intake	Level 1	No swallowing training.
		Level 2	Non-food swallowing training is conducted.
		Level 3	Swallowing training using small amounts of food is conducted.
	Oral intake and alternative nutrition	Level 4	Easy-to-swallow food less than one serving (enjoyment level) is ingested orally, but mainly using alternative nutrition.
		Level 5	One to two meals of easy-to-swallow food are ingested orally. No alternative nutrition is provided.
		Level 6	Three meals of easy-to-swallow food mainly ingested orally, with alternative nutrition for deficiencies.
	Oral intake only	Level 7	Three meals of easy-to-swallow food are ingested orally. No alternative nutrition is provided.
		Level 8	Ingesting three meals orally, except for foods that are particularly difficult to eat.
		Level 9	No food restrictions, ingesting three meals orally.
Normal		Level 10	No problems related to dysphagia (normal).

FIM was conducted by nurses and care workers, the secondary evaluation was reviewed by all staff during meetings, and the tertiary evaluation was confirmed by the team leader who had received FIM training outside the hospital.

5. Statistical analysis

The subjects were divided into two groups: individuals with ROAG scores of less than 9 points at discharge (the "good ROAG group") and those with ROAG scores of 9 points or more (the "poor ROAG group"). The total FIM score at discharge, FIM gain, and FILS score at discharge between the two groups were compared by univariate analysis. Furthermore, multiple regression analysis was performed using the FIM at discharge and the FILS at discharge as objective variables. Statistical Package for the Social Sciences (version 21; IBM Japan, Ltd., Tokyo, Japan) was used for all statistical analyses. Normally distributed continuous variables were expressed as mean ± standard deviation, non-normally distributed continuous and ordinal variables were expressed as median (interquartile range), and nominal variables were expressed as the number of persons (%). Univariate analysis was performed using the unpaired *t*-test, Mann-Whitney *U*-test, and chi-squared (χ^2) test. The significance level was set at less than 5%. Multiple regression analysis was performed using the total FIM score at discharge and FIM gain as the response variables. The covariates were gender, age, days from onset to hospitalization, hemorrhagic stroke, total FIM score at admission, and dichotomized ROAG group at hospital discharge from a clinical perspective.

6. Sample size calculation

Power and Sample Size Calculation (version 3.0; William D Dupont and Walton D Plummer, Department of Biostatistics, Vanderbilt University School of Medicine, Nashville, TN, USA) was used for sample size calculation. Based on a previous study, the difference in the FIM score at discharge between the good and poor ROAG groups was assumed to be 17, with an alpha error of 0.05 and a power of 80%, and the required sample size for each group was estimated to be 59 patients (118 patients in total).

7. Protecting personal information and ethical considerations

This study was designed according to the Declaration of Helsinki and was conducted with the approval of the Research Ethics Review Committee of Hospital A (approval number: NRH-0003). Clinical research information was posted in the wards, outpatient clinics, and other places where patients and their families could see it, and the research subjects and their families were given the opportunity to refuse.

Results

The basic characteristics of the 492 patients are shown in Table 3. Of them, 227 (56.3%) were male, and the mean age was 75.5 ± 11.4 years. Cerebral infarction was the most common disease among the patients (315 patients, 60.4%), followed by cerebral hemorrhage and subarachnoid hemorrhage.

Of the 492 patients, 126 (25.6%) were in the good ROAG group and 366 (74.4%) were in the poor ROAG group at hospital discharge. The median difference between ROAG scores at admission and those at discharge was −5 (interquartile range, −6 to −4), with a decrease in the entire range.

By ROAG item, the most common problem in the poor ROAG group was dental/denture problems with 250 respondents (50.8%), followed by voice problems with 131 respondents (26.6%). A significant difference in the mean age and primary disease was observed between the two groups; however, gender distribution was not significantly different. No difference in the number of days from onset to hospitalization was observed between the two groups. The number of patients who were certified as needing nursing care before illness was 22 (17.5%) in the good ROAG group and 103 (28.1%) in the poor ROAG group with a significant difference. The swallowing status based on the FILS at admission was mostly oral or normal in both the good and poor ROAG groups. BMI was higher in the good ROAG group, and the number of dentist visits was higher in the poor ROAG group. No significant difference in Eichner's classification was observed between the two groups. Significant differences in FIM motor items, cognitive items, and total FIM at admission were found.

The outcomes of the patients are shown in Table 4. A significant difference in all items of the FIM, particularly motor and cognitive items, at discharge was observed between the two groups ($p < 0.001$). The total FIM score, FIM efficiency, and FIM gain at discharge were significantly higher in the good ROAG group than those in the poor ROAG group ($p < 0.001$). No significant difference in hospitalization duration was observed between the poor and good ROAG groups (median 101 days vs. 114 days; $p = 0.31$). Most patients in both groups returned home, with institutions accounting for nearly 30% of patients in the poor ROAG group.

Multiple regression analysis was performed with the total FIM score and FIM gain at discharge as the objective variables. Unimprovement of oral hygiene and function was associated with FIM gain, independent of gender, age, the total FIM score at admission, hemorrhagic stroke, and days from onset to hospitalization (Table 5). Similarly, unimprovement of oral hygiene and function was independently associated with the total FIM score at discharge (partial regression coefficient = −9.889, 95% confidence interval = −13.499

Table 3. Basic characteristics of the subject on admission.

Item	All (*N*=492)	ROAG score at discharge		*P*-value
		Good group (8 points) (*N*=126)	Poor group (9–24 points) (*N*=366)	
Age, mean ± standard deviation	75.47 ± 11.43	72.41 ± 12.07	76.53 ± 11.00	<0.001
Sex, *N* (%)				0.148
Male	227 (56.3)	64 (50.8)	213 (58.2)	
Female	215 (43.7)	62 (49.2)	153 (41.8)	
Primary disease, *N* (%)				0.018
Cerebral infarction	315 (60.4)	75 (59.5)	240 (65.6)	
Cerebral hemorrhage	153 (31.1)	39 (31.0)	114 (31.1)	
Subarachnoid hemorrhage	24 (4.9)	12 (9.5)	12 (3.3)	
Days from onset to hospitalization, median (interquartile range)	24 [18–33]	24 [18–35]	24 [18–32]	0.47
Certification of long-term care insurance before onset, *N* (%)				0.021
Yes	125 (25.4)	22 (17.5)	103 (28.1)	
No	367 (74.6)	104 (82.5)	263 (71.9)	
FIM, median (interquartile range)				
Motor items	33 [17–56]	49 [25–63]	30 [15–53]	<0.001
Cognitive items	19 [13–25]	24 [18–29]	17 [11–23]	<0.001
Total	53 [31–81]	73 [47–90]	48 [28–76]	<0.001
ROAG at admission, median (interquartile range)	14 [13–16]	13 [13–14]	15 [14–16]	<0.001
FILS, median (interquartile range)	8 [7–9]	9 [8–10]	8 [7–9]	<0.001
BMI, mean ± standard deviation	21.7 ± 3.4	22.5 ± 3.7	21.5 ± 3.3	0.004
Dentist visits, *N* (%)				0.009
Yes	176 (35.8)	33 (26.2)	143 (39.1)	
No	316 (64.2)	93 (73.8)	223 (60.9)	
Eichner classification†, *N* (%)				0.260
Group A	118 (24.0)	37 (29.4)	81 (22.1)	
Group B	186 (37.8)	44 (34.9)	142 (38.8)	
Group C	188 (38.2)	45 (35.7)	143 (39.1)	

FILS, Food Intake Level Scale; FIM, Functional Independence Measure; ROAG, Revised Oral Assessment Guide; BMI, Body mass index.
†Group A, intermaxillary contact in four occlusal supporting zones in the premolar and molar regions; Group B, intermaxillary contact not in all occlusal supporting zones; Group C, no intermaxillary contact.

to −6.279). Moreover, according to multiple regression analysis with the FILS score at discharge as the objective variable, unimprovement of oral hygiene and function was associated with FILS. (Table 6).

Discussion

The results of this study examining the relationship between impaired oral hygiene and function and ADLs in recovering patients with stroke showed the following two points. First, improvement in oral hygiene and function was associated with FIM gain. Second, the group with good oral hygiene and function had higher FILS scores at hospital discharge.

Improvement in oral hygiene and function was significantly associated with FIM gain. In a study conducted at a recovery ward, oral dysfunction was an independent explanatory factor for the FIM score at discharge [15] and poor oral hygiene was associated with the FIM score at admission [16], and the results of this study were consistent with those findings. Although the mechanism of the association between improvement in oral hygiene and function and ADLs is unclear, it is possible that the improvement in ADLs is caused by the prevention of the occurrence and development of malnutrition because impaired oral hygiene and function are risk factors for malnutrition, and malnourishment may inhibit the improvement of ADLs [17−19]. Although poor oral hygiene is one of the risk factors for pneumonia, it has been reported

Table 4. Comparison of outcomes between good and poor ROAG score groups at hospital discharge.

Item	All of them (*N*=492)	ROAG score at discharge		*P*-value
		Good group (8 points) (*N*=126)	Poor group (9–24 points) (*N*=366)	
ROAG, median (interquartile range)		1 [0–2]	1 [0–2]	0.019
Length of stay	109 [77–154]	101 [71–151]	114 [79–155]	0.31
Rehabilitation dose	963 [665–1,350]	886 [605–1,339]	1,013 [687–1,352]	0.27
FIM, median (interquartile range)				
Motor items	69 [41–85]	83 [65–89]	61 [34–81]	<0.001
Cognitive items	25 [18–31]	30 [26–34]	23 [16–29]	<0.001
Total	95 [60–114]	112 [94–121]	82 [53–109]	<0.001
FIM efficiency	0.27 [0.14–0.40]	0.32 [0.24–0.44]	0.24 [0.13–0.39]	<0.001
FIM gain	27 [15–40]	32 [22–45]	24 [13–38]	<0.001
Discharge destination				<0.001
Home	337 (68.5)	106 (84.1)	231 (63.1)	
Long-term care facility	135 (27.4)	18 (14.3)	117 (32.0)	
Geriatric health service facility	6 (1.2)	1 (0.8)	5 (1.4)	
Long-term care hospital	13 (2.6)	1 (0.8)	12 (3.3)	
Others	1 (0.2)	0 (0)	1 (0.3)	
FILS, median (interquartile range)	9 [8–10]	10 [9–10]	9 [8–10]	<0.001
ROAG at discharge, median (interquartile range)	9 [8–11]	8 [8–8]	10 [9–11]	<0.001

FILS, Food Intake Level Scale; FIM, Functional Independence Measure; ROAG, Revised Oral Assessment Guide.

Table 5. Multiple regression analysis with FIM gain at hospital discharge as the objective variable.

Explanatory variables	Partial regression coefficient	95% confidence interval		*P*-value
		Lower limit	Upper limit	
Constant	88.957	52.333	104.653	<0.001
Gender (Female)	−5.880	−9.072	−2.689	<0.001
Age	−0.423	−0.573	−0.274	<0.001
Oral hygiene and functional unimprovement	−9.889	−13.499	−6.279	<0.001
Total FIM score at admission	−0.153	−0.211	−0.095	<0.001
Hemorrhagic stroke	1.807	−1.553	5.167	0.291
Days from onset to hospitalization	−0.222	−0.340	−0.103	<0.001

FIM, Functional Independence Measure.

that functional impairment and cognitive decline occurred after the onset of pneumonia and that the onset of pneumonia was reduced when oral hygiene and function were improved by oral care [20]. Preventing the development of pneumonia is assumed to decrease the risk of aggravation of clinical condition, increase the frequency of mobilization, and increase the intensity of the rehabilitation program, which in turn increase the likelihood of completing the rehabilitation program. In contrast, it has been highlighted that impaired oral hygiene and function may be related to malnutrition and sarcopenia [21]; however, the relationship remains unclear [22], and the mechanisms that contribute to improving ADLs require further verification.

The group with good oral hygiene and function had higher FILS scores at discharge. Moreover, it was suggested that the group with good oral hygiene and function was associated with higher FILS scores at discharge because it was the group with the highest degree of improvement in oral hygiene and function.

Although there have been only a few studies on the relationship between oral hygiene and function and ADLs, it has been reported that patients discharged home from a rehabilitation ward in the recovery phase

Table 6. Multiple regression analysis with FILS at discharge as the objective variable.

Explanatory variables	Partial regression coefficient	95% confidence interval		*P*-value
		Lower limit	Upper limit	
Constant	8.525	7.502	9.548	<0.001
Gender (Female)	−0.241	−0.448	−0.033	0.023
Age	−0.020	−0.030	−0.010	<0.001
Oral hygiene and functional unimprovement	−0.294	−0.529	−0.059	0.014
Total FIM score at admission	0.005	0.000	0.010	0.046
Hemorrhagic stroke	0.098	−0.120	0.317	0.378
Days from onset to hospitalization	−0.001	−0.009	0.007	0.810

FIM, Functional Independence Measure.

have a higher degree of independence in oral cleaning, that tongue movement ability is involved in the acquisition of oral intake at discharge in patients with acute stroke, and that the intervention of a dental hygienist increases the likelihood of discharge [23−25]. Furthermore, our previous study showed that tube-fed patients with poor oral hygiene on admission had poor reacquisition of oral intake [26]. It has also been reported that altered oral sensation and nonfunctional oral health are associated with dysphagia [27]. These findings suggest that oral hygiene and sensation can be improved by interventions of dental hygienists, which may also improve the swallowing ability.

In Kaifukuki rehabilitation wards, improvement in oral hygiene and function may be achieved using a multidisciplinary oral approach, including dental hygienists, nurses, and care workers. The role of a dental hygienist in a Kaifukuki rehabilitation ward is to coordinate with the dentist, evaluate oral hygiene, create programs for oral hygiene procedures, and provide guidance to patients and their families regarding oral care materials, such as toothbrushes [28]. It has been reported that the interventions of dental hygienists in Japanese rehabilitation wards are associated with an increase in FIM scores at discharge and the proportion of patients returning home and a reduction in hospital stay and mortality [10, 24]. This suggests that the role of dentists and dental hygienists in Kaifukuki rehabilitation wards is substantial. Moreover, oral care by nursing staff and others in intensive care units is effective in preventing pneumonia [29]. In the "10 articles on nursing and care" by the Kaifukuki Rehabilitation Ward Association, it is recommended that oral care should be provided after each meal, and it is desirable that oral hygiene and function should be assessed and intervention started from the early stages of hospitalization by a multidisciplinary team of dental professionals, nurses, and care workers. Such interventions are be expected to improve the degree of independence in ADLs related to food intake and oral cleaning, which in turn may improve physical and cognitive functions. However, whether oral healthcare contributes to the improvement in ADLs in Kaifukuki rehabilitation wards remains unclear; verification is needed in the future.

This study has several limitations. First, this is a cross-sectional study examining the relationship between improvements in oral hygiene and function and various outcomes, and we could not assess whether improvements in oral function and hygiene will improve outcomes. Decreased Barthel Index and Mini-Mental State Examination and dependence on self-care have also been reported to be associated with impaired oral hygiene and function [30−33], and the possibility of reverse causation was considered, in which swallowing function and saliva volume increase in patients who can perform oral care independently, and oral hygiene and function are preserved [34]. Second, whether the results can be extrapolated to all patients with stroke admitted to Kaifukuki rehabilitation wards is unclear because patients transferred to acute care hospitals or those who died were excluded.

In conclusion, improvement in oral hygiene and function in convalescent patients with stroke was associated with FIM gain. Furthermore, the ability to swallow was found to be associated with the outcomes. We believe that these results support the necessity of improving oral hygiene and function when the goal is to improve rehabilitation outcomes, such as ADLs. Further higher-quality large-scale multicenter and interventional studies are needed.

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