

Relationships between activity of daily living, and oral cavity care and the number of oral cavity microorganisms in patients with cerebrovascular diseases

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Abstract : We examined the relationships among the activity of daily living (ADL), oral cavity care, and the number of oral cavity microorganisms in 40 patients with cerebrovascular diseases (CVD). The CVD patients were classified into 4 groups, I, II, III and IV based on their ADL and the method used for oral cavity care. The ADL was highest in group I and lowest in group III. Only the patients of only group III could not eat by themselves and were receiving naso-esophageal feeding. Oral cavity care was performed by the patients themselves in groups I and IV, but was performed by caregivers in groups II and III. The group IV patients had no teeth, but could eat by themselves using full dentures. The numbers of microorganisms in the pharyngeal swabs from the 4 groups were measured and expressed as colony-forming units (cfu). The numbers of both *Staphylococci* spp. and *Candida* spp. were significantly higher in group III than in the other groups. Moreover, *Pseudomonas aeruginosa* was isolated only from patients of group III (in about 66%). The oral cavity care by caregivers was almost the same in groups II and III, but the numbers of oral cavity microorganisms were significantly higher in group III than in group II. These results indicated that microorganisms grow more easily in the oral cavities of CVD patients with low ADL compared with CVD patients with higher ADL, and that eating is thought to be important for the prevention of an increase of microorganisms in the oral cavity. *J. Med. Invest.* 46 : 79-85, 1999

Key words : oral cavity care, aspiration pneumonia, cerebrovascular disease, pharyngeal swab, bacteria

INTRODUCTION

The function of host neurological defense systems, such as the cough reflex and swallowing reflex is often lowered in aged persons or patients with cerebrovascular diseases (CVD). Such individuals are subject to aspiration pneumonia, because bacteria in the oral cavity and pharynx move easily into the lungs during sleep (1, 2).

Aspiration pneumonia is thought to be caused by pathogens of bacterial flora in the upper airway and oral cavity (3, 4). For instance, it has been reported that the *Streptococci anginosus* group of pathogens are common in aspiration pneumonia (5). Oral cavity care including tooth brushing and gargling is thus thought to be effective not only for the prevention of tooth diseases but also for the prevention of aspiration pneumonia.

Oral cavity care can be classified into that by carried out by oneself and that carried out by a caregiver. The latter is carried out not only by professional oral cavity care managers, but also by nurses, caregivers and family members. It is postulated that in Japan, in the near future, the number of

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persons who cannot take care of their oral cavities by themselves because of disorders such as CVD and dementia may increase because the number of aged persons is now rapidly increasing. Therefore, the need for oral cavity care of these patients by caregivers is also expected to increase.

We are attempting to develop effective new methods for oral cavity care by caregivers from standpoint of the caregivers, for the prevention of both aspiration pneumonia and oral cavity infections in CVD patients who cannot care for their oral cavities by themselves. We speculated that the methods of oral cavity care suitable for individual CVD patients differ depending on the degree of their ADL and on the underlying CVD. Therefore, in this study, we investigated the relationships among the ADL scores, method of oral cavity care, and the numbers of microorganisms in the oral cavity of CVD patients who were hospitalized.

MATERIALS AND METHODS

Study Population

The subjects consisted of 40 CVD patients who were hospitalized in a recuperation hospital. There were 24 males and 16 females, and their ages ranged from 42 to 88 years old. The underlying CVD are listed in Table 1. Informed consent was obtained from each patient or the patient's family. The patients were classified into four groups depending on their ADL and on the content of their oral cavity care as follows. Group I consisted of the 11 patients who could eat and brush their teeth by themselves. Group II was the 12 patients who could eat by themselves but were receiving oral cavity care from caregivers. Group III consisted of 8 patients who were given nutrients via naso-esophageal tube feeding and received oral cavity care from caregivers. Group IV was the remaining 9 patients who had no teeth but could eat with full dentures, and performed their oral cavity care by themselves. Table 1

Table 1. Background of the study population of 40 patients with cerebrovascular disease classified according to their activity of daily living and oral cavity care method

Group*		I N=11	II N=12	III N=9	IV N=8	
Sex	Male	8	10	2	4	
	Female	3	2	6	5	
Age (year)	Mean	62	63	80	79	
	(range)	(42 ~ 67)	(52 ~ 84)	(54 ~ 88)	(64 ~ 87)	
Underlying Disease	Alzheimer's disease	0	0	1	0	
	Subarachnoid hemorrhage	2	0	0	0	
	Spinal cord injury	1	0	0	0	
	Multiple cerebral infarction	2	4	3	3	
	Cerebral infarction	2	3	3	3	
	Cerebral contusion	0	1	0	0	
	Brain tumor	0	0	1	0	
	Cerebral hemorrhage	4	4	1	2	
Bedridden status	Independence	J 1**	0	0	0	0
		J 2	5	0	0	3
	Partially	A 1	1	0	0	0
		A 2	2	0	0	1
	Completely	B 1	1	0	1	1
		B 2	2	10	0	3
		C 1	0	1	0	0
		C 2	0	0	8	0
No. of teeth	Mean	22	15	0	0	
	(range)	(12 ~ 24)	(4 ~ 24)	(0 ~ 24)		

*The patients were classified based on their activity of daily living (ADL) and methods of oral cavity care, as follows ;

Group I : They could brush their teeth and eat by themselves.

Group II : They could eat themselves, but were receiving oral cavity care from caregivers

Group III : They were receiving naso- esophageal feeding and oral cavity care from caregivers

Group IV : They had no teeth, but could eat by themselves using full dentures

**Classification of the bedridden status was carried out based on the criteria reported by the Ministry of Public Welfare of Japan (4).

summarizes the backgrounds, ages, underlying diseases, bedridden status and numbers of remaining teeth of the patients in each group.

The mean age (62 years) of group I was almost the same as that (63 years) of group II. The mean ages of group III (80 years) and group IV (79 years) were almost the same, and higher than that of group I. The number of patient aged over 80 years was 0 (0%) in group I, 1 (8.3%) in group II, 4 (50.0%) in group III and 4 (44.4%) in group IV.

The grading of the bedridden status was performed according to the criteria reported by the Ministry of Health and Welfare of Japan (6). The ADL was the lowest in group III; these patients could not eat or take care of their oral hygiene by themselves because of the existence of disorders such as dysphagia and dementia.

Table 2 shows the history of hospitalization, type of diet, and content of oral cavity care for each group. For the patients of groups II and III, the caregivers wiped the surfaces of the oral cavity and pharynx once a day in the morning with gauze soaked

with povidone iodine (Isodine gargle, Meiji Seika Co., Tokyo, Japan).

The mean frequency of intravenous administration of antibiotics for respiratory infection or urinary infection during the previous 12 months was 2.5 times in group III, and the intravenous administration of antibiotics was not carried out in any of the patients in groups I, II and IV. Patients with decubitus were not found in groups I and IV, but decubitus was found in 3 patients (25.0%) in group II and in 5 patients (55.5%) in group III.

Materials

Mannitol salt agar and NAC agar were obtained from Eiken Co. (Tokyo). *Candida* GE agar was obtained from Nissui Co. (Tokyo). A spiral system (Pleter model D) was obtained from Spiral Co. (Ohio City, OH).

Collection of pharyngeal swabs

To obtain microorganisms from the oral cavity, the mucosa of the pharynx of each patient was

Table 2. Hospitalization, diet and the oral cavity condition of the patient groups

	Mean hospitalization (month) (range)	Diet	Condition of oral cavity
Group I N=11	45.90 ± 36.50*	normal diet ; 10 patients soft diet ; 1 patient	All patients were brushing their teeth at least everyday, and five patients were brushing their teeth after every meal. dental caries ; 6 patients gingival swelling ; 6 patients oral cavity redness ; 3 patients
Group II N=12	57.75 ± 38.01	normal diet ; 2 patients soft diet ; 8 patients mixed diet ; 2 patients	They underwent cleaning of the oral cavity with gauze by a caregiver once a day, in the morning. dental caries ; 6 patients gingival swelling ; 6 patients oral cavity redness ; 6 patients
Group III N=9	19.77 ± 16.87	They were receiving 330-400ml of a commercial liquid diet, MA-8 via a naso-esophageal tube 3 times a day	They underwent cleaning of the oral cavity with gauze by a caregiver once a day, in the morning. no teeth ; 4 patients dental caries ; 1 patient gingival swelling ; 4 patients oral cavity redness ; 4 patients
Group IV N=8	72.75 ± 66.87	normal diet ; 5 patients soft diet ; 3 patients	Seven patients were always wearing their full dentures, and one patient was taking out his full dentures each night. Their dentures were washed with dentifrice, and not washed with washing agent for dentures.

* Values are means ± SD

wiped once with sterilized cotton in the early morning, and the microorganisms on the cotton were immersed in a sterile transport fluid (0.05% sodium thioglycolate in phosphatebuffered saline) for 30 sec.

Measurement of numbers of microorganisms in the pharyngeal swabs

The numbers of *Staphylococci*, *Pseudomonas* spp. and *Candida* spp. were measured by the method reported previously (7). Fifty μl of the original sterilized fluid containing bacteria without dilution was inoculated onto a Mannitol salt agar plate for the measurement of the number of *Staphylococci* spp., and on a *Candida* GE agar plate for the measurement of the number of *Candida* spp. An NAC agar plate was used for counting *Pseudomonas aeruginosa*. The inoculation of the fluid onto agar was performed using the spiral system. The mannitol salt agar plates, NAC agar plates and *Candida* agar plates were incubated aerobically for 2 days at 37 °C, and the number of colonies was counted. The data are expressed as the colony number of each micro-organism per ml (cfu/ml).

Statistical analysis :

The results are expressed as the mean \pm SD. The significance of differences between groups was analyzed by the Fisher's PLSD using Stat View J-45 software. A p value <0.05 was considered significant.

RESULTS

The number of *Staphylococci* spp. in the pharyngeal swabs

The number of patients in whom a *Staphylococci* spp. was detectable was 6 (54.5%) in group I, 8 (66.6%) in group II, 8 (88.8%) in group III and 6 (75%) in group IV. Thus, the rate of *Staphylococci* spp. was the highest in group III. The mean number of *Staphylococci* spp. ($\text{cfu} \times 10^3$) of group III was 1.77, significantly higher than those of the other 3 groups ($p < 0.01$), as shown in Fig.1.

The numbers of *Candida* spp in the pharyngeal swabs

The number of patients in whom *Candida* spp. was detectable was 1 (9.0%) in group I, 5 (41.6%) in group II, 4 (44.4%) in group III, and 6 (75.0%) in group IV. The mean number of *Candida* spp. ($\text{cfu} \times 10^4$) of group III was 1.24, significantly higher than those of groups I and II ($p < 0.05$), but not significantly different from that of group IV (Fig.2).

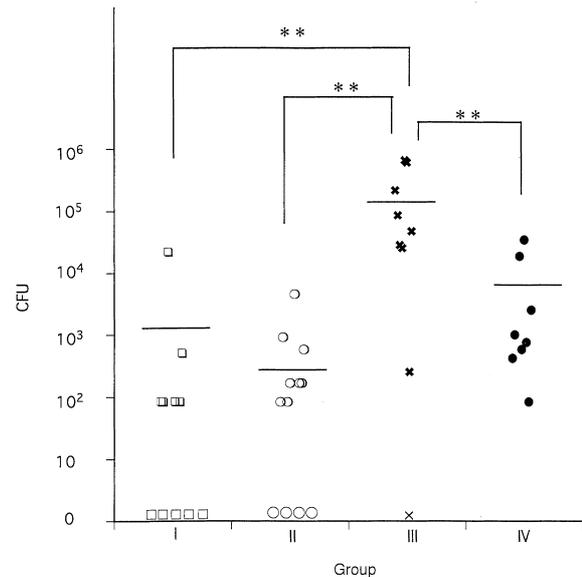


Fig.1. The numbers of *Staphylococci* spp. in pharyngeal swabs. Each symbol represents one patient. Group I, n=11; group II, n=12; group III, n=9; group IV, n=8. Horizontal lines show the means. ** $p < 0.01$

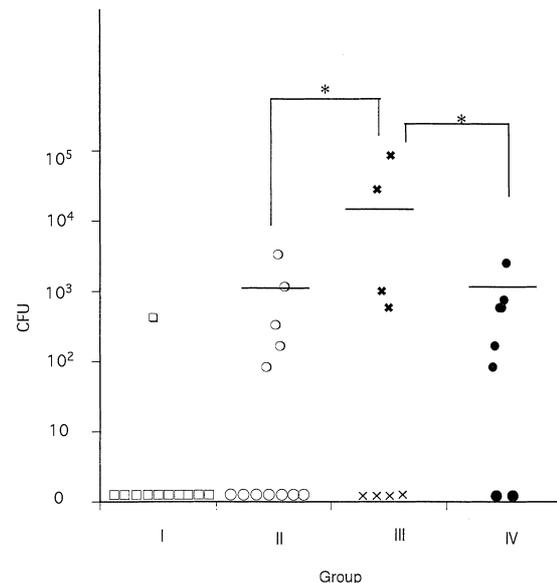


Fig. 2. The numbers of *Candida* spp. in pharyngeal swabs. Each symbol represents one patient. Horizontal lines show the mean. * $p < 0.05$

The numbers of *Pseudomonas aeruginosa* in the pharyngeal swabs

Pseudomonas aeruginosa was not detectable in any samples from the patients of groups I, II and IV. However, it was detectable in 6 patients (66.6%) of Group III. The mean number ($\text{cfu} \times 10^4$) of *Pseudomonas aeruginosa* of group III was 2.56 (Fig.3)

are related to the increase of bacteria in the pharyngeal swabs of group III.

It is well known that various types of bioactive substances such as secretory immunoglobulin A (IgA) and lysozyme, which are related to local host defense in the oral cavity, are present in saliva (9, 10, 14, 15). The present group III patients were given nutrients via a naso-esophageal tube, while the patients of the other groups ate by themselves. Only the patients of group III did not eat or masticate food by themselves. Moreover, the secretion of saliva depends in part on the amount of water intake. The intake of water might be restricted in group III patients compared with subjects who are taking food and water by themselves per os. We therefore suspect that in group III patients, the secretion of saliva is markedly lowered or does not occur, that the local defense system function is lowered or disturbed in the oral cavity, and that factor (1) described above is related to the increase of pharyngeal microorganisms in group III.

The patients of Group III could not care for their oral cavities by themselves due to motor disturbance and or dementia. Moreover, the caregivers often could not perform sufficient oral cavity care for some of the group III patients because the patients did not cooperate with them. Therefore, factor (2) described above also is thought to be related to the increase of pharyngeal microorganisms in group III.

The patients of group III could not eat by themselves, while the patients of group II could eat by themselves. But the patients in both groups II and III received the same oral cavity care by caregivers, namely cleaning of the oral cavity with gauze soaked in povidone iodine. Nevertheless, the number of bacteria and fungi in the pharyngeal swabs was clearly higher in group III than in group II. This result indicates that eating is effective for inhibition of the growth of microorganisms in the oral cavity. Moreover, the fact that the patients of group III were older than those of group II, indicates that some age-related factor may also be related to the difference of numbers of microorganisms between group II and III.

In this study, we did not investigate the functioning of the systemic defense system in the patients.

It is thus unknown whether the systemic defense system function was lowered in the patients, especially in the patients of group III. The group III patients received naso-esophageal feeding over a long term. In general, long-term nutrition through

a naso-esophageal tube is thought to be inadequate for these patients. Moreover, the patients of group III were frequently suffering from infection. We therefore suspect that the nutritional states of the group III patients were poorer than those of the other patient groups, and that the function of the host systemic defense system may also be markedly lower in the patients of group III compared to the other groups. It may be that a decline in the function of the systemic defense system with age was more marked in group III than in group I and II, because the patients of group III were older than those of group I and II.

It is very rare for *Pseudomonas aeruginosa* to be detectable in the pharyngeal swabs of healthy subjects. In the present study, *Pseudomonas aeruginosa* was not detectable in any patients of groups I, II and IV, but was detectable in 66% of the patients of group III. It is well known that *Pseudomonas aeruginosa* appears or increases and displays pathogenicity as a consequence of microbial substitution (change of bacterial flora) due to the administration of antibiotics for the pathogenic bacteria. Moreover, it has been reported that when patients are given nutrients through a naso-esophageal tube, *Pseudomonas aeruginosa* adhere on the tube, form a biofilm, and become resistant to antibiotics (16). Since the present patients of group III had been repeatedly treated by antibiotics for pulmonary, urinary and dermal infections, the *Pseudomonas aeruginosa* detected may have occurred as a consequence of the microbial substitution.

Anaerobic bacteria have been reported to be common pathogens in aspiration pneumonia (17). In this study, we did not analyze the anaerobic bacteria in pharyngeal swabs. We thus do not know whether anaerobic bacteria were increased in the oral cavities of the patients of group III.

The results of the present study indicated that it is necessary to develop effective new methods for oral cavity care administered by caregivers to CVD patients with low ADL, especially for patients who cannot eat by themselves and receive nutrients through a naso-esophageal tube. An enhancement of the functioning of local and systemic host defense systems is also necessary for the prevention of aspiration pneumonia in CVD patients with low ADL.

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