Original Article

Effects of Oral Care Nursing Protocol using a Toothbrush and a Tongue Cleaner for Improving Oral Health Status and Halitosis in General Ward Patients with Acute Stroke

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Abstract - In stroke patients, evidence on the effective oral care guideline is lacking for patients with acute stroke hospitalized in the general ward. We examined the efficacy of an oral care nursing protocol using a toothbrush and a tongue cleaner on the oral health status, halitosis, and aspiration pneumonia rate in stroke patients. It was a non-randomized case-control study. Stroke patients receiving nasogastric tube feeding with dysphagia were enrolled in the acute stage. The two groups had no significant differences in baseline characteristics and stroke severities. Compared with the control group, the intervention group showed significantly higher degrees of improvement in oral health status (0.81 ± 2.69 vs 1.02 ± 2.17, P = .030) and halitosis (0.26 ± 0.88 vs 0.68 ± 0.84, P < .001). The incidence of aspiration pneumonia was not significantly different between the two groups (11.3% vs 9.1%, P = .719). Oral care using fine toothbrushes and tongue cleaners significantly improved oral health status and halitosis in acute stroke patients, suggesting that education and protocol development are widely needed.

Keywords - Oral health, Oral care, Toothbrushing, Tongue cleaner, Stroke, Nursing.

1. Introduction

Patients with acute stroke are at a high risk of aspiration pneumonia due to swallowing difficulties (Yu et al., 2018). Therefore, good oral hygiene in the early stages of a stroke is important (Lyons et al., 2018). Since many stroke patients cannot independently perform oral care, they rely on nurses or their caregivers. Therefore, a nurse-led oral care intervention is important for improving the oral health status of stroke patients (Lyons et al., 2018). For acute stroke patients, it is therapeutically recommended to check their oral condition from the early stages of hospitalization and establish an individual nursing plan (Fujita et al., 2023). Evidence-based oral care guidelines for stroke patients emphasize the importance of comprehensive oral assessment, utilization of oral care tools, and regular and sufficient oral care times (Kwok et al., 2015; Lyons et al., 2018). There is evidence that fine-bristle oral care gently stimulates the mucous membrane and improves oral circulation (Scannapieco, 2021; Sozkes & Sozkes) and that oral care with chlorhexidine at least twice a day is a highly effective method (Jackson & Owens, 2019; Kwok et al., 2015).

Most of the studies implemented an evidence-based oral care guideline using tooth brushing for stroke patients in the ICU (de Camargo et al., 2019; Jackson & Owens, 2019; Sozkes & Sozkes; Zhao et al., 2020) and for chronic stroke patients in nursing homes or rehabilitation hospitals (Ab Malik et al., 2018; Murray & Scholten, 2018).

Although the importance of oral care has been emphasized for stroke patients (Lyons et al., 2018), it has been considered to have a relatively low priority in nursing care (Scannapieco, 2021). Moreover, there has been little research on effective oral protocols for patients with acute stroke in the general ward (GW) (Lyons et al., 2018). In Malaysia, only about a third performed clinical oral care practices daily, and there were deficiencies in oral care knowledge for stroke care (Ab Malik et al., 2018). Besides, bad breath from stroke patients, dirty dentures, time-consuming due to the many numbers of patients per nurse, little formal assessment tools about oral care were shown to be reluctant to perform oral care in the GW (Ferguson et al., 2020; Kwok et al., 2015). In the GW, nurses prefer using the basic gauze-based oral care method rather than the evidence-based oral care protocol involving toothbrushes (Ab Malik et al., 2018; Kwok et al., 2015). Studies on oral health care for stroke patients (Ab Malik et al., 2018; Ferguson et al., 2020; Kwok et al., 2015) showed that nurse-led evidence-based oral care was not routinely provided for stroke patients. Oral health protocols were inconsistent across nurses. The reason for such a phenomenon is the lack of proven oral assessment tools for stroke patients (Ajwani et al., 2017) and the lack of

nurses who received the necessary training (Ab Malik et al., 2018; Prendergast & Hinkle, 2018).

Therefore, evidence-based oral care protocol for patients with acute stroke in the GW should be explored and implemented. However, in tertiary medical centers in South Korea, the average patient-to-nurse ratio is 8.5:1, which prevents nurses from applying comprehensive oral care to such patients. Moreover, there is no guideline on oral care in the Korean Clinical Practice Guideline for Stroke. This study aimed to examine the efficacy of an oral care nursing protocol using a toothbrush and a tongue cleaner to improve oral health status and halitosis and reduce the incidence of aspiration pneumonia in patients with acute stroke in a GW.

2. Methods
2.1. Design
This was a non-equivalent control-group pretest-posttest study. Since a random assignment within one ward was difficult, both groups were collected and proceeded according to the sample size calculation.

2.2. Participants
Participants with acute stroke were recruited from Asan Medical Center, a tertiary general hospital in Seoul, South Korea. Participants met the following inclusion criteria: (1) stroke patients who were admitted to the GW, including the stroke unit, (2) patients who maintained nasogastric tube feeding for at least 5 days with no oral intake after admission to the GW, (3) patients who could not brush teeth on their own, and (4) aged $\geq$ 18 years. Participants were excluded if they met any of the following criteria: (1) patients with a platelet count of less than 50,000/mcl or diagnosed with a blood clotting disorder, (2) patients with dental problems such as bleeding from oral lesions and dental caries, (3) patients with no teeth, (4) patients who had been on nasogastric tube feeding before admission to the GW, and (5) patients unable to participate and cooperate research interventions due to severe cognitive or language impairment.

2.3. Procedures
We created educational materials for patients and caregivers about oral care using a fine-bristle toothbrush and a tongue cleaner, which one neurologist and one dental professor reviewed. The educational materials consisted of papers, pictures, and explanations on the importance of oral care using brushing, oral care preparations, and accurate oral care methods. We conducted a group training for nurses in the ward twice in December 2016 and shared the method with all nurses. The inter-observer reliability of oral health status was Cronbach a = .71, and the inter-observer reliability of halitosis was Cronbach a = .82 for 3 researchers in 23 cases. Based on a previous study that showed a difference in the improvement of oral health due to oral care after 5 days (Kwok et al., 2015), the outcome variables were measured at baseline and on day 5 after the intervention. Nurses

performed oral care once (6 AM), and caregivers performed twice (1 PM, 9 PM) in both groups.

In the control group, the nurse verbally explained to the caregiver before performing oral nursing, while the intervention group was provided with standardized educational papers. Oral care in the control group consisted of wiping the oral cavity with gauze dipped in 0.1% chlorhexidine solution, and that in the intervention group involved the use of a fine-bristle toothbrush and a tongue cleaner (WD746, Wedent Co., Kimpo, Korea) (Wedent, 2018) using 0.1% chlorhexidine solution, which was wiped off with normal
saline (Table 1).

2.4. Ethics
This study was approved by the Institutional Review Board of Asan Medical Center (IRB number: 2016-0267).

2.5. Measures
2.5.1. Clinical Characteristics
We collected the data on patients' clinical characteristics by reviewing the electrical medical records. Neurological characteristics were measured using the National Institutes of Health Stroke Scale (NIHSS) and the modified Ranken Scale (mRS). NIHSS is measured from 0 to 42 points in total depending on the severity of symptoms, with higher scores indicating higher neurological severity (Brott et al., 1989). mRS scores of 0 to 2 indicate the degree of disability that does not require assistance in daily life, 3 to 5 indicate the need for assistance in daily living, and a score of 6 indicates death (van Swieten et al., 1988).

2.5.2. Primary Outcomes
Oral Health Status
Oral health status was assessed using the Modified Oral Assessment Guide, which summed six items of oral health conditions (i.e., lips, gums, mucous membranes, tongue, teeth, and saliva) on a 3-point Likert scale developed by Eilers et al. (Eilers et al., 1988) and translated by Jung (Jung, 1996). Higher scores indicate worse conditions. We used the photographs of inserted tools (Prendergast et al., 2013) by Predergast after obtaining permission. Three researchers assessed oral health status, and inter-rater reliability was measured. Oral health status was assessed 1 hour after oral suction or oral care and was measured on an empty stomach to prevent aspiration.

Halitosis
Halitosis was measured by breathing for 3 seconds with a sound of "ha" at a location about 1 cm away from the measurement area after closing the mouth to collect sulfur compounds in the mouth for 1 minute using the Halimeter (HC-105S, Tanita Co., Japan). Halitosis was assessed 1 hour after oral suction or oral care and was measured on an empty

stomach to prevent aspiration (Cho & Kim, 2012). Halitosis was measured twice with an interval of about 5 minutes, and the average value was used for analysis.

Aspiration Pneumonia

Aspiration pneumonia was defined as a case of aspiration pneumonia treated with antibiotics.

2.5.3. Data collection

The data from the intervention group were collected from January 2017 to September 2017, and those from the control group were collected from May 2016 to November 2016. The electronic medical record was collected after discharge or transfer (Figure 1).

2.5.4. Data Analysis

Group comparisons were performed using the χ^2-test, Fisher's exact test, and Student's *t*-test. The changes in outcome variables were compared between the control and intervention groups using a one-way covariance (ANOVA) analysis by adjusting for baseline outcome variable data collected before the intervention. We used SPSS/WIN 20.0 program for statistical analyses. P values < .05 were considered to denote statistical significance.

Sample size

A total of 84 patients (42 in each) were deemed to be needed according to sample size calculation using G-power analysis 3.1.4 with a significance level of 0.05 and an effect size of 0.8. In a previous study on neuro ICU, the dropout rate was about 30% (Lee & Park, 2015); however, we used a dropout rate of 50% because fewer patients expected nasogastric tube feeding longer in GW than in ICU. Finally, a total of 98 patients (control group, n = 54; intervention group, n = 44) were enrolled.

3. Results

3.1. Demographic and Clinical Characteristics

There were no significant differences in the demographic and clinical characteristics between the control and intervention groups (Table 2).

3.2. Oral Health Status

At baseline, the oral health status was worse in the control group than in the intervention group (10.26 ± 2.25 vs 9.45 ± 2.56, P = .002). The degree of improvement in oral health status was significantly higher in the intervention group (1.02 ± 2.17) than in the control group (0.81 ± 2.69; P = .030) after adjusting for baseline oral health status. Among the specific items, the status of the tongue (0.04 ± 0.73 vs 0.25 ± 0.84, P = .010), saliva (0.26 ± 0.76 vs 0.76 ± 0.78, P = .030), and teeth (0.06 ± 0.63 vs 0.23 ± 0.42, P = .038) showed significantly higher degrees of improvement in the intervention group than in the control group. (Table 2).

3.3. Halitosis

At baseline, halitosis was worse in the control group than in the intervention group (3.25 ± 0.79 vs 1.63 ± 0.79, P < .001). The degree of improvement in halitosis was significantly higher in the intervention group (0.68 ± 0.84) than in the control group (0.26 ± 0.88; P < .001) after adjusting for baseline halitosis (Table 3).

3.4. Aspiration Pneumonia

There was no significant difference in the ratio of aspiration pneumonia between the two groups (11.3% vs 9.1%, P = .719) (Table 3).

4. Discussion

In this study, we found that an oral care nursing protocol using a toothbrush and a tongue cleaner was more effective than using gauze alone in improving the oral health status and halitosis of acute-stage stroke patients undergoing tube feeding (Lyons et al., 2018). Toothbrushing with tongue cleaner could reduce halitosis more effectively than toothbrushing alone due to the removal of the tongue coating (Kuo et al., 2013).

In our study, the baseline oral health status and halitosis were better in the intervention group than in the control group, which is likely due to the fact that patients who could not be adequately instructed on toothbrushing were excluded from the intervention group. In fact, 21 patients with stroke-related impairments in consciousness and speech were unable to maintain an open mouth and were not included in the intervention group because they bit their toothbrushes or applied force to their mouths. In other words, oral care using a toothbrush has disadvantages in that it is difficult to apply to patients who cannot follow accurate instructions or refuse them (de Camargo et al., 2019; Ferguson et al., 2020). In a previous study, the rate of oral care using a toothbrush was low at 16.4%, and that of tongue brushing was also low at 1.5%. Moreover, 64% of patients tended to refuse oral care, such as by turning their heads and pushing or biting the toothbrush (Coleman & Watson, 2006).

Therefore, an effective oral care protocol should be applied for patients who are unable to open their mouths or do not perform well in instructions due to impaired consciousness (Lyons et al., 2018). Besides, oral care training should be provided to stroke nurses so that they do not fall behind in their nursing priorities. Nurses often feel that they are insufficiently trained to effectively deliver oral care (Ferguson et al., 2020), which may be partially due to the fact that oral anatomy, oral assessment, and provision of daily oral care are seldom the focus of nursing curricula (Ferguson et al., 2020; Scannapieco, 2021). Nurses found it difficult to ask what the patient needs in oral care, and there was uncertainty and fear about the best way to provide oral care for stroke patients (Ajwani et al., 2021; Kwok et al., 2015).

Although not statistically significant, the intervention group had a lower rate of aspiration pneumonia than the control group (11.3% vs 9.1%, P = .719). A possible reason for the lack of statistical significance is that the study period was limited to an average of 5 days. Another reason may be the nurse-to-patient ratio. In a previous study that reported reductions in the incidence of aspiration pneumonia with oral care using brushing in the ICU, the nurse-to-patient ratio was 1:2 and patients who were not applied oral care were directly administered by a nurse twice a day (Prendergast et al., 2013). Considering the nursing conditions in South Korea, it is difficult for nurses to directly provide oral care to patients every 8 hours in the ward. The possible reason for the lack of statistical significance could be that the number of times nurses can perform in the ward is relatively small.

This study has the following limitations. With a relatively short observation period of 5 days, long-term outcomes could not be measured, especially in terms of the development of aspiration pneumonia. In addition, the degree of candida bacteria or plaque in the saliva could not be objectively measured, and the reliability of caregivers who performed oral care could not be obtained. Lastly, we only enrolled patients receiving tube feeding and did not include other types of patients with dysphagia.

Although our results showed that an oral care nursing protocol using a toothbrush and a tongue cleaner improved the oral health status, stroke survivors had not received various oral care information from nurses despite changes in their oral status due to stroke (Ajwani et al., 2021; Dalimunthe et al., 2019; Lyons et al., 2018), especially in the acute stages of stroke. Nurses are the best place to conduct oral assessments and can also be trained to identify patients who may need further oral treatments (Lyons et al., 2018). Therefore, stroke units may benefit from applying oral care protocols and providing the relevant training for nurses. There is no consensus on the oral care approach in stroke patients (Ferguson et al., 2020; Lyons et al., 2018), so follow-up studies are needed.

5. Conclusion

Oral care nursing protocol using a toothbrush and a tongue cleaner significantly improved oral health status and halitosis in acute stroke patients undergoing tube feeding. Education and protocol development is needed so nurses can easily apply oral care to stroke patients. Wide application of an oral care nursing protocol using a toothbrush and a tongue cleaner to stroke patients may be beneficial.
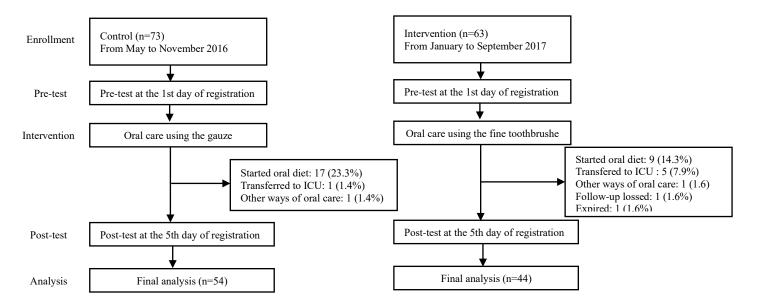
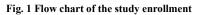## Acknowledgments

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Table 1. Comparison of Oral Care Between the Control and Intervention Groups

	Control (2016.5–2016.11)	Intervention (2017.1–2017.9)
Time of oral care	6 AM (Nurse)-1 PM (Caregiver)-9 PM (Caregiver)	
Solution	0.1% Chlorhexidine	0.1% Chlorhexidine
Tool	Gauze, tweezers	Fine toothbrush and a tongue cleaner Gauze, tweezers
Education to caregiver	Nurses educated caregivers verbally and demonstrated the procedure before the 1st oral care	Nurses educated caregivers verbally and demonstrated the procedure before the 1st oral care, and provided educational print-outs
Ways of oral care	1. Brushing : Wipe teeth, gum, oral mucosa, and tongue for about 2 minutes with a gauze soaked in 0.1% chlorhexidine 2. Lips apply vaseline ointment	1. Brushing 1) Brush all teeth with a fine toothbrush soaked with 0.1% chlorhexidine back and forth, inside and outside, for about 2 minutes 2) Tongue cleaner : Gently scrape the tongue back and forth for about 30 seconds 2. Mouth rinse : Wipe the teeth, gum, oral mucosa, and tongue with a gauze soaked in normal saline 3. Lips : Apply vaseline ointment

Fig. 1 Flow chart of the study enrollment

Table 2. Comparisons of Baseline Demographics and Clinical Characteristics

Characteristics		Control (n = 54)	Intervention (n = 44)	
		N (%) or mean ± SD		*p*
Male, n (%)		25 (46.3)	23 (52.3)	.556
Age (yr)		74.4 ± 8.5	74.7 ± 10.4	.901
Admission route	Emergency room	21 (38.9)	14 (31.8)	.298
	Intensive care unit	31 (57.4)	30 (68.2)	
	General wards	2 (3.7)	0 (0.0%)	
NIHSS on admission		13.23 ± 5.52	14.55 ± 6.71	.291
MRS on admission		4.19 ± 0.86	4.43 ± 0.76	.156
Hospital days of Starting the tube feeding		3.33 ± 5.17	2.93 ± 2.06	.635
Finishing the tube feeding		17.12 ± 11.82	14.91 ± 11.35	.356
BMI on admission		22.55 ± 5.25	22.83 ± 3.59	.767
Albumin on admission (g/dL)		3.48 ± 0.51	3.59 ± 0.52	.282
Smoking	None or ex-smoker	49 (90.7)	40 (90.9)	.999
Alcohol	None	36 (66.6)	32 (72.7)	.739
	Less than 7 days/week	13 (24.1)	8 (18.2)	
	everyday	5 (9.3)	4 (9.1)	
Medications	Steroids	0 (0.0)	0 (0.0)	
	Immuno-suppressants	2 (3.7)	0 (0.0)	.499[*]
Oral suction	None	8 (14.8)	5 (11.4)	.859
	8 hours per day	11 (20.4)	10 (22.7)	
	4 hours per day	35 (64.8)	29 (65.9)	
O2 applied		18 (33.3)	13 (29.5)	.665
NIHSS at discharge		13.32 ± 5.56	13.05 ± 7.39	.835
MRS at discharge		4.47 ± 0.87	4.39 ± 0.97	.649
Hospital days of research registration		4.28 ± 4.36	5.43 ± 4.74	.213
Length of research duration days		5.83 ± 0.67	5.64 ± 0.92	.237
Length of stay or transfer days		16.18 ± 10.66	15.51 ± 9.52	.704

BMI; body mass index, MRS; Modified Ranken Scale, NIHSS; National Institutes of Health Stroke Scale, SD; standard deviation
[*]analyzed by Fisher's exact test

Table 3. Comparisons of Oral Health Status, Halitosis and Aspiration Pneumonia

Variables	Baseline			Final			Differences (baseline-final)		
	Control	Intervention		Control	Intervention		Control	Intervention	
	Mean ± SD		p	Mean ± SD or n (%)		p	Mean ± SD		p
Oral health status	10.26 ± 2.25	9.45 ± 2.56	.002	9.45 ± 2.56	7.91 ± 1.90	.001	0.81 ± 2.69	1.02 ± 2.17	.030[*]
Lips	1.85 ± 0.63	1.36 ± 0.53	<.001	1.62 ± 0.63	1.27 ± 0.59	.006	0.23 ± 0.72	0.09 ± 0.68	.135[*]
Tongue	1.85 ± 0.66	1.80 ± 0.59	.678	1.89 ± 0.67	1.55 ± 0.63	.678	0.04 ± 0.73	0.25 ± 0.84	.010[*]
Saliva	2.08 ± 0.51	1.82 ± 0.54	.018	1.81 ± 0.68	1.48 ± 0.55	.018	0.26 ± 0.76	0.76 ± 0.78	.030[*]
Mucose	1.60 ± 0.69	1.20 ± 0.46	.001	1.38 ± 0.66	1.16 ± 0.43	.061	0.23 ± 0.80	0.05 ± 0.53	.365[*]
Gingiva	1.26 ± 0.66	1.18 ± 0.50	.412	1.19 ± 0.49	1.11 ± 0.32	.314	0.08 ± 0.51	0.07 ± 0.45	.456[*]
Teeth	1.62 ± 0.79	1.57 ± 0.50	.591	1.57 ± 0.54	1.34 ± 0.48	.034	0.06 ± 0.63	0.23 ± 0.42	.038[*]
Halitosis	3.25 ± 0.79	1.63 ± 0.79	<.001	3.00 ± 0.78	1.00 ± 0.49	<.001	0.26 ± 0.88	0.68 ± 0.84	<.001[†]
Aspiration pneumonia Ratio				6 (11.3%)	4 (9.1%)				.719
Days of diagnosed				3.14 ± 1.68	2.25 ± 0.50				.335

SD; standard deviation
[*] adjusted by baseline oral health status
[†] adjusted by baseline halitosis