Title: At Home Breathing Exercise for the Elderly using a Party Horn: An Exploratory Study

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COMFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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Abstract

Objective: To test the efficacy of at-home breathing exercises for the elderly using a party horn.

Methods: Maximum phonation time (MPT), swallowing speed, and maximum voluntary tongue pressure (MVTP) were recorded before and after the 6-month exercise period in 53 medically stable elderly subjects. **Results:** MPT, swallowing speed, and MVTP significantly improved in 26 (49.0%) participants who continued the exercise throughout the study period, while swallowing speed significantly decreased in those who did not continue the exercise (n = 21).

Conclusion: Blowing into a party horn is feasible for the elderly and may maintain their respiration and swallowing.

Key words: aspiration, dysphagia, long-term care, pneumonia, swallowing

INTRODUCTION

Advance in the aging of the population is a large strain on the country's finances as it raises its expenditures on public pensions and items related to health insurance. Therefore, in countries with aging populations, it is extremely important to properly prevent and treat the medical conditions peculiar to the elderly. Pulmonary complications associated with decreased respiratory and swallowing functions, such as aspiration pneumonia, are common in elderly individuals.[1] Interventions to improve respiratory and swallowing functions may reduce the incidence of pneumonia, but breathing exercises with health professionals are not provided in many facilities, nor well-tolerated among the elderly. Therefore, it may be beneficial to develop a simple and effective exercise method that anyone can perform with or without health insurance coverage.

The Fukimodoshi, also known as a 'party horn' or 'party blower' is a traditional Japanese toy that is also now available in east Asian countries, North America, and Europe. It is a horn formed from a paper tube, often flattened and rolled into a coil, and unrolls when blown into, producing a horn-like noise (Fig. 1). Most elderly people will have played with such toys in their childhood and, therefore, are familiar to them. Recently, a breathing exercise using the Fukimodoshi has been used in some rehabilitation wards, nursing homes, and day care facilities[2], but its effect of

home exercise is uncertain. The aim of this exploratory study was to test the safety, feasibility, and efficacy of an at-home breathing exercise for the elderly using the Fukimodoshi.

METHODS

Setting, Participants, and Breathing Exercise

This study was a retrospective analysis of prospectively collected data regarding a breathing exercise using the Fukimodoshi. Fifty-three medically stable elderly subjects (age > 60 years) receiving day care services under Kaigo Hoken[3], the long-term nursing-care insurance system for the elderly, were recruited from 10 day care facilities in Nagasaki and Fukuoka, Japan, between January 2010 and June 2011. The long-term care insurance covers elderly people with any type of disease who need nursing care. To use the service provided by the insurance, the necessity of nursing must be recognized (authorization of nursing care requirement). Exclusion criteria were as follows: communication difficulty due to severe dementia; severe cardiac disease, severe pulmonary disease, and/or severe physical disability; history of chronic obstructive pulmonary disease and/or asthma; severe dysphagia necessitating supplemental tube feeding; severe respiratory dysfunction (Hugh-Johns classification > II); terminal cancer; pneumonia at the beginning of the study; and currently participating in another clinical study. No subject met the exclusion criteria.

Fukimodoshi (Lupinus Co. Ltd, Hiroshima, Japan) especially manufactured for breathing exercises were used in the study. The expiratory pressure for unrolling was set at 30 ± 8 cm H_2O. The participants received group training on blowing using the Fukimodoshi 30 times under the guidance of a speech-language pathologist when attending day care. They were then instructed to continue the same exercise at home 3 times a day, 5 days a week for 6 months. The at-home exercises were monitored by the attending speech-language pathologist each time the participant attended day care. Those who accomplished the at-home exercises for the whole study period were retrospectively assigned to the accomplished group, and their results were compared with those who did not follow the instructions (non-accomplished group). This study was conducted in accordance with the principles set forth in the Helsinki Declaration and was approved by the Medical Ethics Committee of the Nagasaki Medical Center. All the participants had given their informed consent before initiation of the breathing exercises.

Measurements

Baseline swallowing function was assessed with a modified water swallowing test.[4] Participants in a sitting position were asked to drink 3 mL of cold water 3 times. They were judged to be dysphagic if they experienced wet hoarseness or choking at least once after swallowing 3

times.

Nursing care level (between 1 and 5 based on assessment of care requirements, with 1 corresponding to mild and 5 corresponding to severe) was calculated according to the officially provided formula.

To evaluate respiratory function, maximum phonation time (MPT) was measured using a stopwatch with the participants seated.[5] Participants were asked to produce a sustained vowel /a:/ for as long as possible and were verbally encouraged during this effort. The method, variability, and reliability of this measurement were previously described.[6] Three consecutive trials were performed with a 15-second break between trials. The highest value measured was considered the MPT (s) index in the present study.

A 100-mL water swallowing test (WST) was performed for the swallowing function measurement.[7] First, the participants were seated upright and asked to place a glass of 100-mL of distilled water to their lips. On receiving a “go” signal, they drank the water in the glass as quickly as possible. The swallowing time was measured from the “go” signal to the end of the WST. For those who successfully finished the glass of water, the end of the WST was defined

as completion of the last swallow, indicated visually by the return of the thyroid cartilage to its resting position. Signs of choking or a wet hoarse voice after testing were recorded. Participants who choked during swallowing were asked to stop drinking immediately regardless of whether they had finished the water. In such cases, the stopwatch was stopped as soon as choking occurred. The amount of water drunk was determined by subtracting the volume of residual water from 100 mL. Swallowing speed (mL/s), defined as the amount of water drunk divided by the elapsed time on the stopwatch, was calculated.

Maximum voluntary tongue pressure (MVTP) was measured with a hand-held balloon probe and a manometer (JMS Co. Ltd, Hiroshima, Japan).[8] Participants in a relaxed sitting position were asked to place the balloon on the anterior part of the palate. To eliminate compromising the power of closing the mandible by the anterior teeth or residual ridge, the end of the plastic cylinder crossed the teeth/ridge arch. They were then asked to raise their tongue and compress the balloon onto the palate for approximately 7 s with their maximum voluntary effort. Three consecutive trials were performed at 1-min intervals, and the highest value measured was defined as the MVTP (kPa). The MPT, swallowing speed, and MVTP were measured at the beginning and end of the 6-month breathing exercise period. All measurements were performed by one of the authors (KY).

Statistical analysis

Means and standard deviations (SD) or percentages were used to describe participants' characteristics. Wilcoxon rank-sum tests were used when comparing two independent quantitative variables, and Wilcoxon signed-rank tests were used to compare two paired variables. The χ^2 test with Yates correction or Fisher's exact test was used for categorical analysis. All statistical analyses were performed with EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria). More precisely, it is a modified version of R commander designed to add statistical functions frequently used in biostatistics.[9]

RESULTS

Participants used the day care service 1–3 times per week. All participants were followed throughout the intervention period, and no participant experienced adverse cardiopulmonary events. Six participants were excluded from the retrospective analysis because they were not able to finish one or more of the MPT, swallowing speed, and MVTP measurements. The results of 26 participants who completely followed the instructions and performed breathing exercises at home throughout the study period (accomplished group) and 21 who did not follow the

instructions (non-accomplished group) were compared.

The baseline characteristics and measurements of the participants are shown in Table 1. There were no significant differences in age, sex, nursing care level, or dysphagia between the groups. MPT (11.3 ± 5.6 to 13.4 ± 6.5 s; $P = 0.004$), swallowing speed (7.6 ± 5.9 to 10.3 ± 6.9 mL/s; $P = 0.001$), and MVTP (18.3 ± 7.3 to 20.2 ± 7.7 kPa; $P = 0.002$) significantly increased after the exercise period in the accomplished group (Table 2). In the non-accomplished group, there was no significant increase in the 3 measurements but there was a significant decrease in swallowing speed (11.7 ± 5.1 to 8.7 ± 4.7 mL/s; $P = 0.006$). Comparison of changes in MPT, swallowing speed, and MVTP between the groups revealed a significant increase in swallowing speed in the accomplished group (-3.0 ± 4.1 vs. 3.0 ± 4.0; $P < 0.001$) (Table 3).

DISCUSSION

The breathing exercise using a traditional toy called the Fukimodoshi, which is generally familiar to elderly Japanese, was fairly well-tolerated, with 49.0% (26/53) of the participants being able to continue the at-home exercise for 6 months. Swallowing function assessed by swallowing speed significantly improved in those who continued the exercise, compared to the non-accomplished group. Swallowing function in the elderly deteriorates naturally, as seen in the

non-accomplished group; therefore, this result may highlight a positive effect of the Fukimodoshi exercise on swallowing.

The effects of pulmonary rehabilitation including walking, cycling, and strengthening of the breathing and peripheral muscles in patients with chronic lung disease have been confirmed in a randomized control trial.[10] The efficacies of some rehabilitative interventions to improve swallowing, such as a head-raising exercise [11] and the Mendelsohn maneuver[12], have been reported. However, to undertake such exercise training, patients must train hard and usually require the assistance of a health professional. In contrast, the Fukimodoshi exercise is cheap and enjoyable compared to formal rehabilitation exercises, such as pursed lip breathing and incentive spirometry, and can be easily performed without supervision. Interventions to prevent pulmonary complications in elderly people should be widely performed even when health insurance does not cover the intervention; therefore, the Fukimodoshi breathing exercise may be a good self-training method to prevent pneumonia.

In the current study, MPT was used to evaluate the respiratory function rather than spirometric evaluation, because spirometers were not available at any of the day care facilities where the study was performed. MPT is widely used to evaluate maximum vocal capacities because it is

noninvasive, quick, and inexpensive. MPT is related to pulmonary functions such as forced vital capacity in myopathic patients[13] and forced expiratory volume in 1 second ($FEV_{1.0}$) after thyroplasty.[14] Zhou et al.[15] found a significant correlation between MPT and aspiration in acute stroke patients. Therefore, we considered MPT as a measurement for assessing pulmonary function and aspiration in this study, but the optimal method to evaluate the effects of using the Fukimodoshi for breathing exercise needs to be further explored.

This study had certain limitations. First, because one of the aims of the study was to evaluate the feasibility of an at-home exercise, the effect of using the Fukimodoshi for breathing exercise was analyzed between retrospectively assigned groups. The accomplished group participants did the Fukimodoshi exercise to some degree, but the exercise compliance of the intervention group subjects cannot be accurately assessed. Therefore, it was very difficult to clearly divide the subjects into the intervention and control groups. Second, the effects of the breathing exercise on health, such as effects on the incidence of pneumonia, were not confirmed due to the short follow-up period.

CONCLUSIONS

At-home breathing exercise developed with the Fukimodoshi was feasible and well-tolerated by

the elderly participants, and the exercise may improve respiratory and swallowing functions. The intervention protocol employed in the study can be safely used. Future research should evaluate the health effects of using the Fukimodoshi for breathing exercise compared to a control group in a randomized control trial.

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TABLES

Table 1. Baseline characteristics and measurements of the participants.

*Level of significance: P <0.05.

Table 2. Comparison before and after the 6-month exercise.

*Level of significance: P <0.05.

MPT: maximum phonation time.

MVTP: maximum voluntary tongue pressure.

Table 3. Changes before and after the 6-month exercise.

*Level of significance: P <0.05.

MPT: maximum phonation time.

MVTP: maximum voluntary tongue pressure.

FIGURE

Figure 1. Photo of Fukimodoshi, ‘party horn’. Grandmother and granddaughter playing with the party horn.

Table 1

	All (n = 53)	Non-accoplished (n = 21)	Accoplished (n = 26)	P-value*
Age, years, mean (s.d.)	82.4 (7.9)	80.6 (8.7)	82.2 (8.8)	0.285
Gender, male, n (%)	18 (34.0)	9 (42.9)	9 (34.6)	0.782
Nursing care level, mean (s.d.)	1.2 (0.8)	1.3 (0.9)	1.3 (0.8)	0.797
Dysphagia, n (%)	6 (11.3)	1 (5.0)	5 (19.2)	0.204
MPT, s, mean (s.d.)	11.2 (5.5)	11.0 (5.4)	11.3 (5.6)	0.906
Swallowing speed, mL/s, mean (s.d.)	9.0 (5.9)	11.7 (5.1)	7.6 (5.9)	0.006
MVTP, kPa, mean (s.d.)	18.5 (8.5)	18.9 (10.0)	18.3 (7.3)	0.847

Table 2

	Non-accomplished (n = 21)			Accomplished (n = 26)		
	pre	post	*P*- value*	pre	post	*P* -value*
MPT, s, mean (s.d.)	11.0 (5.4)	12.7 (7.2)	0.177	11.3 (5.6)	13.4 (6.5)	0.004
Swallowing speed, mL/s, mean (s.d.)	11.7 (5.1)	8.7 (4.7)	0.006	7.6 (5.9)	10.3 (6.9)	0.001
MVTP, kPa, mean (s.d.)	18.9 (10.0)	19.4 (10.7)	0.728	18.3 (7.3)	20.2 (7.7)	0.002

Table 3

	Non-accoplished (n = 21)	Accomplished (n = 26)	P- value*
ΔMPT, s, mean (s.d.)	1.7 (5.1)	2.2 (3.4)	0.359
ΔSwallowing speed, mL/s, mean (s.d.)	-3.0 (4.1)	3.0 (4.0)	0.000
ΔMVTP, kPa, mean (s.d.)	0.5 (9.5)	1.9 (4.5)	0.077

Figure 1