

clarify the inter-relationships among nutritional factors with mortality in the present model with such a small sample.

In conclusion, we demonstrated an association between malnutrition and 38-month mortality in Japanese frail elderly. The present results suggest two very potent and convenient predictors of mortality in older nursing home residents. The two indicators, mid-arm circumference and low lipid intake, may be useful for many kinds of assessments and intervention for the improvement of health conditions in Japanese frail elderly. Further studies of Japanese frail elderly are needed to clearly understand the contribution of nutritional status to survival.

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ORIGINAL ARTICLE

# Nutritional assessment of elderly Japanese nursing home residents of differing mobility using anthropometric measurements, biochemical indicators and food intake

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**Background:** Awareness and evaluation of individual nutritional status are required for optimal support of the elderly population. A Japanese Anthropometric Reference Data (JARD 2001) was established as a new gold standard, however, its utility for very frail elderly with differing mobility and the relationship with biochemical parameters and food intake remains unclear. The purpose of this study was to investigate the possible relationship between nutritional status and mobility deficits in Japanese nursing home residents, and to compare the ability of JARD 2001 to detect malnutrition with other indicators.

**Methods:** In 130 Japanese nursing home residents (26 men, 104 women; mean age  $82.2 \pm 9.0$  years), anthropometric measurements (body mass index, mid-arm circumference, triceps skinfold thickness and calf circumference), serum markers (albumin, total protein, prealbumin, retinol binding protein, total cholesterol, HDL-cholesterol, triglyceride, white blood cells, erythrocyte, hemoglobin and lymphocytes) and food intake were assessed. The nutritional indicators were compared among categories according to severity of mobility deficits, and the ability to detect malnutrition was examined in each parameter.

**Results:** The bedridden elderly had significantly lower nutritional indicators, including anthropometric indexes, albumin, HDL-cholesterol and food intake, compared with other elderly who can move with or without a wheelchair. When protein-energy malnutrition was defined as below 1.2 g/kg/day protein intake, 36.7% of the residents were considered to have an intake deficiency. The JARD 2001 was better able to identify the deficiency than albumin level in the independent and the chair-bound, while albumin could detect the malnourished subjects more sensitively than anthropometric measurements in the bedridden.

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**Conclusion:** Poor nutritional indicators could relate with mobility deficits among institutionalized Japanese frail elderly. The ability of indicators to detect malnutrition diverged with the severity of mobility deficits. The JARD 2001 criteria should be adopted for the elderly with at least an ability to move about by wheelchair, and appropriate anthropometric reference standards for very frail people must be reconsidered.

**Keywords:** Japanese frail elderly, JARD 2001, malnutrition, mobility deficits, nutritional assessment, serum albumin.

## Introduction

The number of aged people has increased rapidly in developed countries, and about 18.0% of the Japanese population were aged 65 or older in 2001.<sup>1</sup> Elderly individuals usually have various health problems, such as chronic diseases and physical frailty. In addition to the fact that the amount of daily food intake is an important contributory factor in the progression of frailty, up to 15% of ambulatory outpatients and 25% to 60% of institutionalized elderly have been reported as malnourished.<sup>2-4</sup> Thus, optimal nutritional support, including assessment and intervention, are needed to minimize frailty in the elderly, especially institutionalized people with a high risk of malnutrition.

Malnutrition has been mainly evaluated by anthropometrical and biochemical parameters.<sup>5</sup> Information about nutritional status in nursing home residents with physical frailty, particularly mobility deficits, is still very limited in Japan. Additionally, the specific indicators for nutritional assessment of older patients of differing mobility remain to be analyzed. In 2001, Japanese Anthropometric Reference Data (JARD 2001) were firstly established as a new gold standard for nutritional assessment based on non-invasive methods.<sup>6</sup> It provides the anthropometric norms for healthy men and women in each 5-year age bracket, including over aged 61, and enables evaluations in relation to the body composition. However, the relationship between the JARD 2001 and other nutritional indicators, such as biochemical parameters and food intake, in nutritional assessment has not been examined.

The purpose of this study is to investigate the possible relationship between nutritional status and mobility deficits in Japanese nursing home residents, and to examine the utility of JARD 2001 in nutritional assessment of frail elderly by comparing its ability to detect malnutrition with other nutritional indicators, including biochemical parameters and food intake.

## Methods

### *Participants*

Data were obtained from frail elderly living in two nursing homes in Aichi Prefecture, Japan. The study popu-

lation consisted of 130 participants, including 86 residents from one institute (total of 150 residents) and 44 from another (total of 80 residents). Their informed consent and/or that of their guardians was obtained in writing.

### *Protocol*

The project was approved by the ethical committee of National Chubu Hospital. Anthropometric measurements were taken of height, weight, mid-arm circumference (AC), triceps skinfold thickness (TSF) and calf circumference (CC). Body mass index (BMI) was calculated by a general equation based on the height and weight. Biochemical parameters analyzed included albumin, total protein, prealbumin, retinol binding protein (RBP), total cholesterol, HDL-cholesterol, triglyceride (TG), white blood cells (WBC), erythrocytes (RBC), hemoglobin (Hb) and lymphocytes. The dietary intake history based on the provided menu was investigated by a trained dietitian by interview with the participants or their carers about the residue and additional supplements. On the basis of the dietary history for one month before the anthropometric and biological measurements were taken, the 24-h intake of energy and macronutrients (protein, lipid and carbohydrate) was estimated and calculated as a mean value. Mobility deficits in the present study were classified into three categories modified from the mobility classification of the Japanese Official Long-term Care System:<sup>7</sup> independent (ability to move with or without a supportive device), chair-bound (requiring a wheelchair for movement) and usually bedridden.

Malnutrition was defined with regard to the level of each parameter. The cut-off points of each anthropometric index were defined based on the criteria of JARD 2001 (chapter 6).<sup>6</sup> A patient in the 50th percentile below the norm of age- and sex-matched healthy controls was considered a case of malnutrition if he/she had an ability to move with or without wheelchair (independent and chair-bound). For a patient who requires complete assistance in daily activities (bedridden), fifth percentile below the norm was applied as the criteria for malnutrition. A serum albumin level of 3.5 g/dL was arbitrarily selected as the cut-off point to define malnutrition since

it has been widely accepted in previous studies.<sup>8-12</sup> In addition, an individual was classified as nutritionally deficient if their food intake was less than the recommended dietary allowance (RDA) for Japanese elderly (over aged 70). The RDAs of energy and protein intake were estimated as 27–32 kcal/kg/day and 1.1–1.2 g/kg/day, respectively, by calculating according to the basal metabolic energy and the standard body weight for those of the Japanese reference data aged over 70.<sup>13</sup> In this study, thus, we adopted 30 kcal/kg/day for energy and 1.2 g/kg/day for protein as the cut-off point of intake deficiency.

### Data analysis

Values are presented as means  $\pm$  standard deviation (SD). Group differences among the three categories regarding severity of mobility deficits in the nutritional indicators were evaluated using analysis of variance (ANOVA) with Fisher's post hoc test. Additionally, Pearson correlation coefficients between anthropometric indices and biochemical parameters or food intake were calculated by a regression analysis.

An SPSS statistical package (Statistical Product and Service Solution) was used for all analyses, and statistical significance was established at  $P < 0.05$ .

## Results

### Sample description

Details of the characteristics of subjects in the present study are given in Table 1. We classified 130 elderly according to the severity of mobility deficits: 23.8% (seven men and 24 women) were independent, 39.2% (12 men and 39 women) were chair-bound, and 36.9% (seven men and 41 women) were bedridden. There were no differences in the distribution between genders, and the mean age did not differ among the three groups. The bedridden included 31 elderly who required assistance in feeding.

### Relationship between nutritional status and degree of dependency

Nutritional indicators were compared among the three groups according to the severity of mobility deficits (Table 2). In all anthropometric measurements except

for TSF, the bedridden had significantly lower values than other groups. Anthropometric measurements were the same in the independent and the chair-bound. Moreover, the serum albumin level in the bedridden was significantly lower than in the other groups. A significantly lower level of HDL-cholesterol was found in the bedridden compared with the independent. Differences in food intake in relation to mobility deficits are also shown in Table 2. With the gradual progression of deficits, energy intake of protein, lipid and carbohydrate significantly decreased. Carbohydrate intake per body weight (g/kg/day) was lower in the bedridden than in the independent and the chair-bound, whereas there were no differences in the adjusted intakes of protein and lipid among the three groups.

### Comparison in detection of malnutrition between JARD 2001 and other nutritional indicators

Anthropometric measurements had a good correlation to serum albumin and prealbumin level (Table 3). Additionally, BMI, AC and CC correlated with food intake.

On the basis of the cut-off points for malnutrition for each indicator, the nutritional status of individuals was assessed. We observed 24.8% to 66.4% of malnourished residents according to the indicators and their criteria (Table 4). Over 70% of the independent were estimated to suffer from malnutrition by the JARD 2001, excluding CC, whereas malnutrition was true in only 4.4% to 35.6% of the bedridden. On the other hand, estimation according to the serum albumin level led to classification of 19.4% of the independent and 58.7% of the bedridden as malnourished. About 30–40% of the subjects with a lower intake than the RDA values of energy and protein were detected, irrespective of severity of mobility deficits. Furthermore, the ability to distinguish protein intake deficiency ( $< 1.2$  g/kg/kcal) was compared between the criteria of the JARD 2001 (AC) and that of the albumin. The cut-off point of the AC could identify 70% and 84.2% of the subjects with low protein intake in the independent and the chair-bound, respectively. Only 25% of the protein-intake deficiency in the bedridden was identified as being malnutrition by the AC. Using the criteria of albumin ( $< 3.5$  g/dL) 52.9% of the

**Table 1** Characteristics of subjects

	All	Independent	Chair-bound	Bedridden
<i>n</i>	130	31	51	48
Gender (females), %	80.0	77.4	76.5	85.4
Age, years (SD)	82.2 (9.0)	81.3 (9.0)	81.5 (8.7)	83.4 (9.5)

**Table 2** Nutritional status in relation to degree of dependency (mean – SD)

	Independent	Chair-bound	Bedridden
Anthropometric measurements			
Body mass index, kg/m <sup>3</sup>	20.2–3.0	19.7–3.7	17.2–3.2*#
Mid-arm circumference, cm	22.4–2.7	21.3–2.9	19.8–2.8*##
Triceps skinfold thickness, mm	10.7–6.7	9.6–5.6	9.1–5.3
Calf circumference, cm	33.6–2.9	31.9–4.7	27.7–4.1*#
Biochemical parameters			
Total protein, g/dL	7.0–0.5	6.9–0.5	6.8–0.6
Albumin, g/dL	3.8–0.4	3.6–0.3	3.4–0.4*#
Prealbumin, mg/dL	19.9–5.7	20.4–5.1	17.9–5.7
Retinol binding protein, mg/dL	3.0–1.2	3.1–1.2	2.8–1.2
Total-cholesterol, mg/dL	206.1–48.4	194.8–33.9	190.9–44.9
HDL-cholesterol, mg/dL	56.8–11.2	53.3–11.8	49.3–12.2**
Triglyceride, mg/dL	102.9–64.7	106.4–53.0	104.1–59.5
White blood cells, × 10 <sup>2</sup> /μL	59.5–12.1	61.6–18.2	63.8–18.2
Erythrocytes, × 10 <sup>4</sup> /μL	381.7–45.5	398.8–58.4	381.9–65.1
Hemoglobin, g/dL	11.7–1.4	11.8–1.5	11.8–1.8
Lymphocytes, per cent	30.4–8.6	28.0–9.0	30.9–9.3
Food intake			
Energy, kcal/day	1538.7–380.8	1376.3–278.0**	1079.7–245.7*#
kcal/kg/day	36.1–9.6	33.7–7.2	31.1–8.9**
Protein, g/day	56.2–11.4	52.0–9.0	44.4–10.9*#
g/kg/day	1.32–0.31	1.28–0.26	1.28–0.41
Lipid, g/day	34.4–6.4	30.6–5.6*	26.6–6.4*#
g/kg/day	0.81–0.18	0.75–0.15	0.76–0.21
Carbohydrate, g/day	246.0–71.9	218.6–48.9**	163.0–40.5*#
g/kg/day	5.77–1.76	5.35–1.24	4.71–1.47*##

\* $P < 0.01$ ; \*\* $P < 0.05$  versus independent; # $P < 0.01$ ; ## $P < 0.05$  versus partly dependent.

**Table 3** Correlation between anthropometric measurements and nutritional parameters

	Anthropometric measurements			
	Body mass index	mid-arm circumference	Triceps skinfold thickness	Calf circumference
Biochemical parameters				
Albumin	0.320*	0.470*	0.238*	0.492*
Prealbumin	0.226**	0.347*	0.248*	0.271*
Total-cholesterol	0.156	0.162	0.120	0.191**
HDL-cholesterol	-0.044	-0.077	-0.198**	-0.073
Food intake				
Energy	0.205**	0.322*	0.143	0.393*
Protein	0.139	0.233*	0.127	0.295*
Lipid	0.220**	0.335*	0.137	0.382*
Carbohydrate	0.199**	0.318*	0.140	0.388*

\* $P < 0.01$ ; \*\* $P < 0.05$ .

malnourished subjects could be discriminated in the bedridden, whereas there was no relation between protein-intake deficiency and a low albumin level in the independent.

## Discussion

Food intake reduction could be an early sign of worsening health. It is also reported that low food intake is

**Table 4** Prevalence of malnutrition based on different nutritional parameters

Parameters	Cut-off value	Proportion of malnutrition, % (n)			
		Independent	Chair-bound	Bedridden	All
JARD 2001					
Body mass index	50th or 5th percentile of norms	70.0 (21)	66.0 (33)	25.5 (12)	52.0 (66)
Mid-arm circumference	50th or 5th percentile of norms	76.7 (23)	88.0 (44)	35.6 (16)	66.4 (83)
Triceps skinfold thickness	50th or 5th percentile of norms	70.0 (21)	4.4 (2)	66.0 (33)	44.8 (56)
Calf circumference	50th or 5th percentile of norms	20.0 (6)	36.0 (18)	15.6 (7)	24.8 (31)
Biochemical parameter					
Albumin	< 3.5 g/dL	19.4 (6)	33.3 (17)	58.7 (27)	39.1 (50)
Recommended dietary allowance					
Energy	< 30 kcal/kg/day	26.7 (8)	31.4 (16)	42.6 (20)	34.4 (44)
Protein	< 1.2 g/kg/day	33.3 (10)	39.2 (20)	36.2 (17)	36.7 (46)
Prevalence of protein intake deficiency (< 1.2 g/kg/day) according to the parameters					
< 1.2 g/kg/day (n)	–	10	20	17	46
Mid-arm circumference	50th or 5th percentile	70.0 (7)	84.2 (16)	25.0 (4)	60.0 (27)
Albumin	< 3.5 g/dL	0 (0)	20.0 (4)	52.9 (9)	27.7 (13)

negatively related to survival in frail nursing home residents.<sup>14</sup> Nutritional supplementation is more effective in preserving the nutritional state and reducing mortality in previously well-nourished patients than in malnourished ones.<sup>15</sup> Mishima *et al.* reported that, even in bedridden elderly, administration of an enteral diet for 8 weeks served to restore the albumin level.<sup>16</sup> Thus, nutritional supplements may play an important role in health care for all elderly irrespective of their level of frailty, and the awareness and evaluation of the individual nutritional status is required in order to be able to provide optimal support.

Anthropometric measurements and biochemical parameters are useful to assess individual nutritional status.<sup>5</sup> In the present study on nutritional status in relation to severity of mobility deficits, the bedridden elderly had a significantly lower anthropometric index, and lower serum albumin and HDL-cholesterol compared with the independent and the chair-bound. Our findings are consistent with those of a previous report that plasma levels of proteins and lipids, including albumin and HDL-cholesterol, were significantly lower in the bedridden elderly than in outpatients.<sup>16</sup> The relationship between AC and/or albumin level and deterioration of physical function has been well demonstrated in both cross-sectional and longitudinal studies.<sup>16-18</sup> Nevertheless, few studies conducted concomitant evaluations using physical parameters and food intake. In our observation, energy intake, even if adjusted for weight, was lower in the bedridden than in the independent and the chair-bound. The present findings strongly support the suggestion that nutritional status deteriorates with progression in frailty.

There has been no consensus about a standard indicator and definition of malnutrition, despite the

importance of nutritional assessment of the frail elderly. Thus, the different prevalence of malnutrition has been detected according to the indices chosen for the assessment and the arbitrary cut-off points for normal and abnormal values.<sup>19,20</sup> In the present study, we found that 24.8% to 66.4% of residents were malnourished according to the indicators and their criteria, whereas the anthropometric measurements correlated with serum albumin or food intake. Furthermore, the ability of indicators to detect malnutrition ranged widely with the severity of mobility deficits. The energy deficit based on the same RDA, for example, for different mobility may over-estimate, since the bedridden elderly have 20–30% lower basal metabolic energy than a control group of elderly.<sup>21</sup> On the other hand, similar rates of protein deficits were detected irrespective of the severity of mobility deficits.

Our study examined the utility of JARD 2001 for nutritional assessment of frail elderly in comparison with other nutritional parameters. When protein-energy malnutrition was defined as below the RDA protein intake (1.2 g/kg/day), 36.7% of the residents were considered to have an intake deficiency. Use of the AC criteria in the JARD 2001 allowed us to identify 70.0% and 84.2% of the independent and the chair-bound, respectively, as deficient. However, in the bedridden, only 25.0% of the deficient elderly were detected using the AC cut-off point. Our results suggest that the JARD 2001 should be adopted for the elderly with at least an ability to move about in a wheelchair. In addition, further research may be necessary to reconsider appropriate anthropometric reference standards for extremely frail people, such as the bedridden.

Anthropometric measurements can be used to reliably and non-invasively evaluate the long-term consequence

of nutritional intake based on the body composition. Mid-arm circumference and TSF are indicative of muscle protein mass and adipose reserve.<sup>22,23</sup> Grading our subjects on the basis of the definition of the JARD 2001, over 70% of the independent elderly were estimated to be malnourished using either the AC or TSF.

Our observations suggest that the frail elderly with an ability to move should be given vigorous nutritional support. In spite of the obvious difference in the activity level, indeed, protein and lipid intake per body weight did not differ in relation to severity of mobility deficits. However, nursing home residents in our study had a relatively adequate nutritional intake based on the RDA, though the intake was not closely monitored in the month before the physical measurements. Frail elderly with an ability to move with or without a wheelchair may show insufficient food intake on the basis of the RDA in order to maintain and/or improve their physical function. There is a similar suggestion that the RDA for protein may not be adequate to completely meet the metabolic and physiological needs of virtually all older people, since even the elderly who achieved the recommended protein intake displayed a loss of skeletal muscle.<sup>24</sup>

Despite the fact that the criteria in the JARD 2001 underestimated malnourishment in subjects with severe physical frailty, the serum albumin cut-off point (< 3.5 g/dL) served to detect malnutrition in 58.7%, including eight subjects with hypoalbuminemia (< 3.0 g/dL), of the bedridden elderly. Our finding suggests that serum albumin might be a more sensitive parameter than anthropometric measurements for nutritional assessment of the very frail elderly, such as those who are bedridden. Albumin, as well as AC, has been acknowledged as a good indicator of long-term protein deficiency, because its serum concentration could reflect changes in visceral protein status and current ability to synthesize proteins.<sup>22</sup> Numerous reports have indicated that a low serum albumin concentration could most significantly predict mortality in an elderly population.<sup>25-28</sup> However, we were unable to clearly detect any protein intake deficiency among the frail elderly able to ambulate in the present study using the serum albumin level of 3.5 g/dL as the cut-off point. The criteria may be insufficient to screen ambulatory elderly with a risk of malnutrition. From comparison of the JARD 2001 with other indicators, the present results imply that the choice of indicators and the criteria for nutritional assessment should be decided according to the severity of physical frailty among subjects.

In conclusion, this study confirms the significant relation between poor nutritional indicators and the severity of mobility deficits among elderly residents of Japanese nursing homes. Although we detected a relatively large number of malnourished residents, the prevalence of malnutrition varied widely (24.8–66.4%)

according to the parameters and the criteria. There was also considerable divergence in the ability of parameters to detect malnutrition in relation to the severity of mobility deficits. The present results suggest that the cut-off point of anthropometric parameters based on the JARD 2001 should be adopted for the elderly with at least an ability to move about by wheelchair. Moreover, we propose the necessity to reconsider appropriate anthropometric reference standards for very frail elderly persons, especially the bedridden. On the other hand, serum albumin might be a more sensitive parameter than anthropometric measurements for nutritional assessment of such people. Further research is required in order to establish an optimal method for nutritional assessment of the frail elderly, especially requiring the sensitivity and specificity of nutritional parameters in intervention trials.

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observed in other studies.<sup>3-6</sup> We attribute this result mostly to the older mean age of our cohort.<sup>2</sup>

Examining Perucchini et al.'s<sup>1</sup> sample, the mean age is higher (76.8, range 63-98) than that observed in our cohort. The overall tolerability was lower, and contrary to our<sup>1</sup> and other studies,<sup>3-5</sup> IV+PV was better tolerated than IV alone.

With the purpose of assessing the variation of incidence of adverse effects with age, we stratified the vaccinees into five age groups. As shown in Table 1, the incidence of adverse effects demonstrates a significantly decreasing trend with the increase in age, from 16.2% at aged 65 to 69 to 12.3% at age 85 and older chi-square ( $\chi^2$ ) for trend  $P < .001$ .

The observed decreasing overall trend is significant in the IV+PV group (from 19.8% at 65-69 to 12.5% at  $\geq 85$ ;  $\chi^2$  for trend  $P < .001$ ) and remains significant for the local (from 15.2% at 65-69 to 9.6% at  $\geq 85$ ;  $\chi^2$  for trend  $P < .001$ ) and the systemic symptoms (from 7.8% at 65-69 to 4.3% at  $\geq 85$ ;  $\chi^2$  for trend  $P < .001$ ) (Table 1). Those receiving only IV did not show a significant variation in the incidence of adverse effects by age group.

Female subjects showed a higher reactogenicity than men (16.1 vs 13.1) and a significant decreasing trend in incidence of adverse effects by age (from 18.2% at 65-69 to 12.8% at  $\geq 85$ ;  $P < .001$ ). The significant trend persisted when analyzing local symptoms (from 14.4% at 65-69 to 10.4% at  $\geq 85$ ;  $\chi^2$  for trend  $P < .001$ ) separated from the systemic ones (from 6.1% at 65-69 to 3.5% at  $\geq 85$ ;  $\chi^2$  for trend  $P < .001$ ).

In conclusion, we agree with Perucchini et al.<sup>1</sup> and other authors<sup>3-8</sup> that simultaneous administration of IV and PV is safe and well tolerated in older people.

The lower incidence of adverse effects observed in our investigation could be related to the older mean age of the subjects examined than in other studies<sup>3-6</sup> or to the shorter follow-up period.<sup>1,7</sup>

What does not convince us, and is contradictory to our and to other conclusions,<sup>3-7</sup> is the observation by Perucchini et al. that the incidence of adverse effects was higher in those receiving IV only than in those receiving IV+PV; only the limited size of their sample could explain this.

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#### RECREATIONAL REHABILITATION IMPROVED COGNITIVE FUNCTION IN VASCULAR DEMENTIA

*To the Editor:* Dementia is a major problem in developed countries from the medical and economic points of view. Various nonpharmacological therapies for dementia, such as life review, reality orientation, behavioral treatment, sensory stimulation, music therapy, physical therapy, and occupational therapy, have been reported,<sup>1-5</sup> but there has been no study to suggest that nonpharmacological therapies can activate cognitive function itself in demented patients. We investigated whether recreational rehabilitation improves cognitive function in vascular dementia (VD) and Alzheimer's disease (AD).

Four hundred twenty-nine patients were admitted to the Comprehensive Geriatric Unit at the National Center of Geriatrics and Gerontology, Obu, Japan, between August 1, 1998, and December 31, 1999. The 267 patients who were diagnosed as nondemented were excluded. Demented patients with complications such as pneumonia ( $n = 18$ ), acute heart failure ( $n = 14$ ), gastrointestinal disease ( $n = 12$ ), acute stroke ( $n = 11$ ), dehydration ( $n = 6$ ), fractures ( $n = 4$ ), orthopedic disease without fracture ( $n = 4$ ), respiratory disease without pneumonia ( $n = 4$ ), urinary tract infection ( $n = 2$ ), and other disease ( $n = 5$ ) were also excluded. Consequently, the subjects in this study were 37 patients with AD (11 men and 26 women) and 45 patients with VD (13 men and 32 women). The demented patients were treated with recreational rehabilitation alone, including playing board games, doing crafts, playing musical instruments, playing balloon volleyball, and dancing. Recreational rehabilitation was performed 5 days a week from Monday to Friday in the meeting room of the Comprehensive Geriatric Unit. One occupational therapist and one nurse organized a 90-minute therapy session for about 10 patients. To determine whether recreational rehabilitation improves cognitive function in demented patients, Mini-Mental State Examination (MMSE<sup>6</sup>) scores were measured before and after recreational rehabilitation.

Age, female:male ratio, Katz index of activities of daily living, physical self-maintenance scale,<sup>7</sup> morale scale, and MMSE before recreational rehabilitation were not different

Table 1. Cognitive Function Before and After Recreational Rehabilitation in Alzheimer's Disease and Vascular Dementia

Subjects	Mini-Mental State Examination Score		P-value
	Before	After	
	Mean $\pm$ Standard Deviation		
Alzheimer's disease (n = 37)	14.5 $\pm$ 6.6	14.9 $\pm$ 6.6	.35
Vascular dementia (n = 45)*	13.5 $\pm$ 5.1	15.0 $\pm$ 5.5	.004
$\geq 30$ sessions (n = 15)*	14.3 $\pm$ 4.9	16.7 $\pm$ 5.2	.008
$18 \leq < 30$ sessions (n = 15)	13.9 $\pm$ 4.9	14.8 $\pm$ 5.9	.28
< 18 sessions (n = 15)	12.3 $\pm$ 5.6	13.4 $\pm$ 5.1	.27

\*Statistically significant.

between VD and AD. MMSE scores did not improve in patients with AD with recreational rehabilitation ( $P = .35$ ) but improved significantly in patients with VD ( $P = .004$ ) (Table 1). According to the frequency of treatments, these patients with VD were divided into the following three groups of 15 patients each (<18 sessions,  $18 \leq < 30$  sessions, and  $\geq 30$  sessions). Of the three subgroups of VD, the most frequently treated group showed a significant improvement ( $P = .008$ ), whereas the other two subgroups did not.

Previous cross-sectional studies have reported associations between dementia and reduced participation in leisure activities in midlife, as well as between cognitive status and participation in leisure activities in old age.<sup>8,9</sup> A recent paper reported that leisure activity might prevent the occurrence of new dementia.<sup>10</sup> The rationale was that participation in leisure activities might increase cognitive reserve, delaying the clinical or pathological onset of dementia. The present study demonstrated that recreational rehabilitation did not improve cognitive function in AD but did in VD and that the most frequently treated group of the three subgroups of VD showed significant improvement, whereas no improvement was seen in the less-frequent groups. These findings clearly suggest that frequent recreational rehabilitation is an effective therapy for the cognitive function in VD.

In our preliminary study, single photon emission computed tomography using N-isopropyl-p-<sup>123</sup>I idampheta-mine was performed in 11 patients with VD who were treated with recreational rehabilitation. These patients were initially divided into two groups based on changes in MMSE scores during recreational rehabilitation. The improved group (6 of 11 patients) had a gain of 3 or more points in MMSE scores, and the no-improvement group (5 of 11 patients) had a gain of 2 points or less. The improved group showed a significantly greater decrease in cerebral blood flow in the frontal region than the no-improvement group ( $P < .05$ ). The no-improvement group showed a remarkably patchy decrease of blood flow in all regions ( $P < .001$ ). In the present study, these findings suggested that cognitive function in patients with a frontal reduction using assessment of cerebral blood flow might improve more than in patients with a patchy decrease in blood flow. The explanation for our findings is not clear. One explanation

might be that the recreational rehabilitation increased cerebral blood flow in the prefrontal region: activation of the cognitive function may occur if cerebral blood flow in the prefrontal lobe is lower at rest than in all regions.

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# 転倒・骨折予防のプログラム

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## KEY WORD

骨粗鬆症  
転倒予防  
骨折予防  
運動療法  
ヒッププロテクター

## POINT

- 当院では、転倒による骨折を予防する診療システムとして、1つの外来で骨粗鬆症リスクと転倒リスクの評価と介入を行う体制を立ち上げた。
- 骨粗鬆症リスクには骨粗鬆症治療(骨吸収抑制薬投与など)、転倒リスクには転倒予防介入(転倒予防教室)を行う。
- 当院で行っている転倒予防教室での筋力強化およびバランス訓練を主体とした運動プログラムについて概説した。
- 両介入でも対応できないような施設入所レベルの要介護高齢者で、まだ寝たきりにはなっていない者にはヒッププロテクターを考慮する。

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## はじめに

高齢者の骨折のうちで、脊椎骨折は転倒が関与せず発生するものが少なくなく、その73%は自覚症状のない、レントゲンで初めて診断される形態的骨折とされ<sup>1)</sup>、入院や手術などの必要はないため、その臨床的意義は少ない。かたや、転倒によって生じる骨折は、大なり小なり、疼痛という急性症状が伴って、否応なくADLも低下するため、医療機関での治療や介護施設での療養を余儀なくされることが多い。大腿骨頸部骨折がその代表である。このように転倒による骨折の臨床的意義は、形態的骨折よ

り明らかに大きく、高齢化社会を迎えてその予防の必要性が高まっており、どのような診療体制が転倒による骨折の予防に有効であるかが問われている。現段階でわれわれの施設は、まだその解答を出せるような状況にはないが、最近始まったばかりの診療体制を紹介する。

## 骨粗鬆症外来と転倒予防外来の融合

高齢者の骨折の原因となる病態は骨粗鬆症と転倒である。前者は骨の量と質の低下によって骨強度が下がり、骨折の準備状態を形成する。後者は、脆弱性の進んだ骨が実際に骨折する直接の契機となる。したがって、転倒による骨折を予防しようとするプログラムにおいては、骨粗鬆症と転倒に対する評価と介入が対等に同時進行で行われることが必要で、骨粗鬆症医学と

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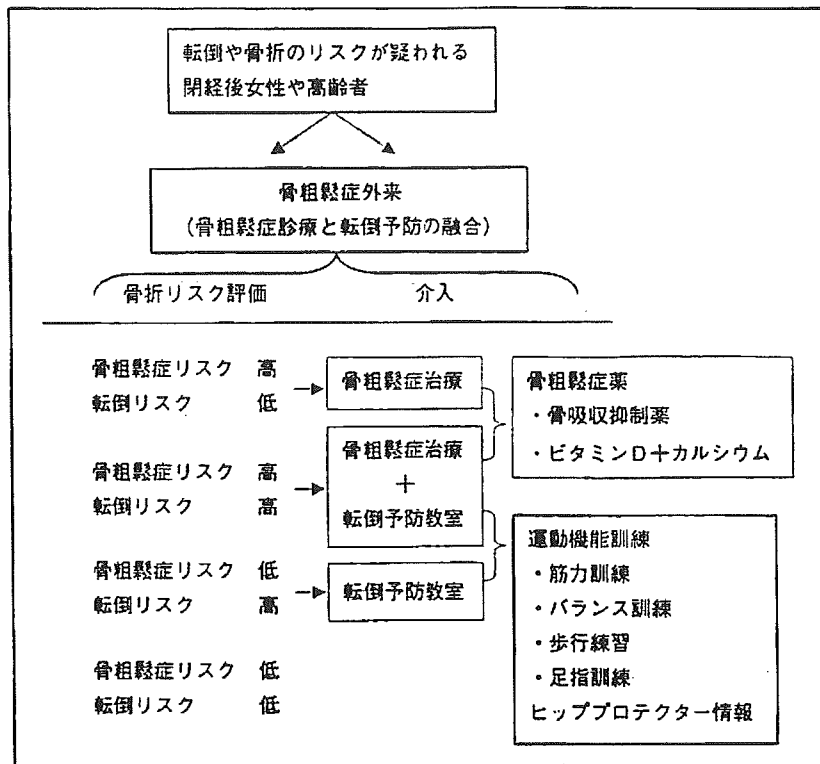


図1 骨折予防診療の流れ

転倒予防医学が車の両輪として機能するプログラムが求められるところであろう。

われわれの病院では、そのようなシステム構築への足がかりとして、最近、骨粗鬆症外来と転倒予防外来のドッキングのような診療システムの変更を行った。従来、当施設では骨粗鬆症外来は整形外科および内分泌内科の医師によって行われ、転倒予防外来はリハビリテーション科医師によって担当され、両者は独立した診療を行っていた。しかし、前述したような理由を強く感じるようになったため、両者を融合させるべく、骨粗鬆症外来の担当医師を整形外科、内分泌内科、婦人科、リハビリテーション科に拡大して、その診療内容を骨粗鬆症による骨折リスクと転倒による骨折リスクの両方に対する評価と対策を盛り込んだ形にした(図1)。このような診療システムの命名は、本来なら転倒・骨折予防外来となるべきと考えられたが、一般患者への普及がまだ十分でないと思われたので、

現時点では骨粗鬆症外来の呼称を用いている。

骨粗鬆症外来では、表1のような転倒・骨折リスクの評価を多岐にわたって施行する。その結果、骨密度と脊椎レントゲンによる原発性骨粗鬆症の診断基準<sup>2)</sup>に基づいて、骨粗鬆症と診断されれば、骨粗鬆症治療介入を行う。一方、ふらつきや転倒既往など、転倒リスク<sup>3,4)</sup>が高いと判断されれば、転倒予防教室へ紹介して介入を行う。両方のリスクを合併する場合は、骨粗鬆症治療と転倒予防教室の両方を施行する(図1)。

骨粗鬆症の治療選択は、後期高齢期、あるいは骨折既往があるなど、骨折リスクの高度な者や、予防骨折部位として脊椎骨折だけでなく大腿骨頸部骨折を考える者にはアレンドロネートやリセドロネートなど、ビスホスホネートの強力な骨吸収抑制薬を使用し、閉経後から前期高齢期までの年代、あるいは骨折既往がないなど、骨折リスクが中等度で予防骨折部位として脊椎骨折だけを考える者には、ラロキシフェンなど

表1 骨粗鬆症と転倒のリスク評価

評価項目	骨粗鬆症 リスク	転倒 リスク
身体基本情報		
年齢	○	○
身長、体重、閉経年数、出産数、喫煙	○	
現在の運動		○
転倒・骨折既往		
脊椎骨折、その他の骨折	○	
転倒		○
既往歴・合併症		
不整脈、起立性低血圧		○
高血圧、高脂血症、脳出血、脳梗塞	○	
心不全、虚血性心疾患	○	○
脳循環不全、一過性脳虚血発作		○
硬膜下血腫		○
パーキンソン症候群	○	○
痴呆	○	○
脊髄後索障害、末梢神経障害、小脳障害、てんかん発作		○
骨関節炎、関節リウマチ		○
ミオパチー		○
白内障、屈折異常、眼鏡不適合、緑内障		○
1型糖尿病	○	○
2型糖尿病	○	○
甲状腺疾患、性腺機能不全、クッシング症候群、卵巣摘出		○
術、胃切除後、逆流性食道炎、肝障害、胃潰瘍、腎不全	○	
喘息		○
使用薬剤		
睡眠薬、精神安定薬、抗不安薬、抗うつ薬、その他の抗精神薬、降圧利尿薬、その他の降圧薬、血管拡張薬、非ステロイド鎮痛消炎薬、強心薬、抗パーキンソン病薬、鉄剤		○
ステロイド薬	○	
骨粗鬆症	○	
家族歴		
母の骨折歴		○
骨密度		
腰椎、大腿骨、全身骨	○	
脊椎X線		
胸椎、腰椎	○	
血液検査		
Ca、P、骨吸収マーカー、骨形成マーカー	○	
PTH、1,25(OH) <sub>2</sub> D、TSH、Free T <sub>3</sub>	○	
運動機能		
握力、膝伸展力、開眼片足立ち、最大1歩幅、10m歩行		○
速度		

マイルドな骨吸収抑制薬を使用する。いずれの場合でも、ビタミンDやカルシウムの不足がある者にはビタミンD剤とカルシウム剤併用などの補充治療を行う。

### 転倒予防プログラム

転倒予防教室のシステムは、全部で8週間の

コースからなり、第1週に運動機能評価を行い、週1回5週にわたる転倒予防を目的とした運動を指導し、第7週に運動機能の再評価を行い、最後の週に評価内容の説明と今後の自宅での運動および生活指導を行うシステムである(図2)。運動機能の評価としては、転倒および日常生活に関する問診、大腿四頭筋筋力、大腿四頭筋での反応時間、重心動揺、握力、10m歩行時間

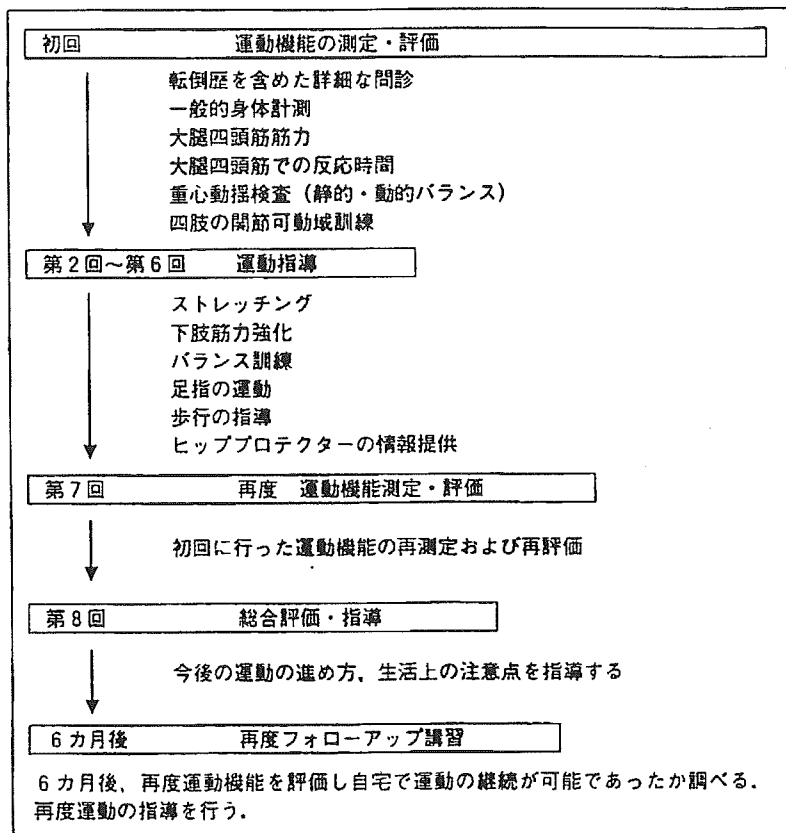


図2 国立長寿医療センターにおける「転倒予防教室」のシステム

などを評価している。

転倒予防教室の具体的な訓練内容は、ストレッチング訓練、下肢筋力の強化、歩き方の練習、自宅でもできる体操の指導、ピーダマを足指でつかんだり、裸足でタオルを巻取ることによる足指の練習、バランス訓練、片足立ち、ボール訓練などである。下肢筋力強化としては、2回目に座位で可能な重垂バンドやテラバンドを用いた練習を行う(図3)。また、同じ日に転倒の現状、原因を理解してもらう講習も行う。3回目には、ストレッチ運動と、棒体操を指導する(図4)。また、同じ日に転倒によって生じる骨折、運動の必要性について講習する。4回目にはバランス訓練を指導する。バランス訓練としては、片足立ちおよびつま先立ちの練習などがある。また、継ぎ足歩行の練習、立位にてできるだけ大きく側方・前方へのステップング、端

座位でできるかぎり離れた位置に手をついてもどる練習、四つ這い位で上下肢の挙上運動などを行う。また、ボールをつかった遊びも取り入れている。また同じ日に、歩行の指導として、前を向いて腹を軽くしめて、歩幅を広くとるように歩き、踵から着地し、足先で地面を蹴るように歩くように指導している。第5回目には、自宅で行える、あまり道具を用いないで可能な運動を指導する。また同じ日に、杖やシルバーカーなどの歩行補助具について講習を行う。6回目は、今まで指導してきた運動を自宅で行えるか復習を行う。7回目には再度運動機能評価を行い、転倒予防教室の効果を判定する。8回目には、再評価の結果について説明し、今後自宅で運動を続けることを指導する。そして6カ月後に来院していただき、運動機能の再評価と転倒の有無、運動の継続について問診し、再度

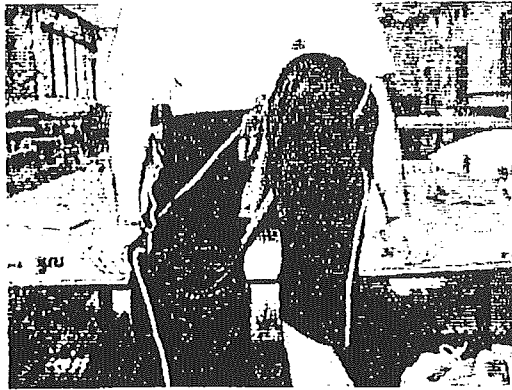


図3 座位での下肢筋力強化

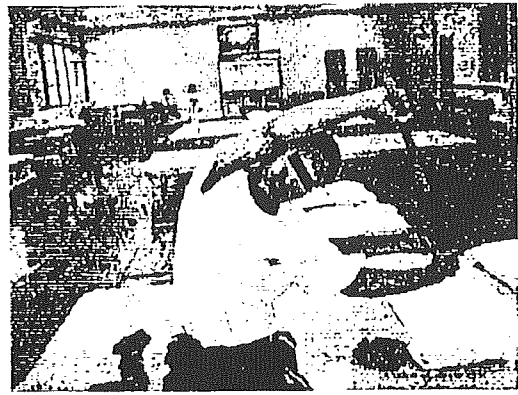
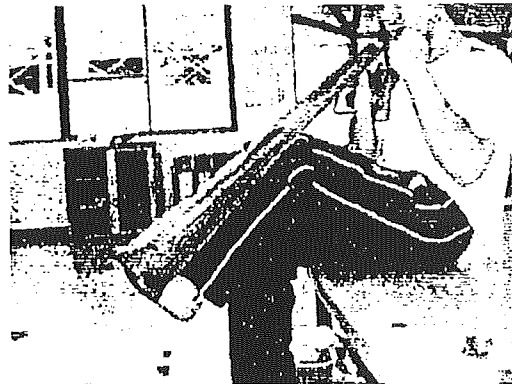


図4 棒体操



図5 足の指の運動

運動指導を行う。以上が当院で行っている転倒予防教室のシステムおよび運動プログラムである。

当院での転倒予防教室の効果としては、大腿四頭筋での反応時間の短縮、10 m 歩行時間の短縮、大腿四頭筋や握力の筋力増強が認められ

ている。転倒予防を目的とした運動療法により、歩行機能の改善を認めた。しかしながら、転倒しやすい虚弱高齢者では、運動機能に個人差が大きく、また運動機能以外にも転倒に関与する因子が多いため、一律の運動指導を行うよりも、この転倒予防教室で行っているように対象者ごとの運動機能を評価して、個人の運動機能に適合した運動を指導することが必要であると考えている<sup>5-7)</sup>。

#### ヒッププロテクターの使用について

最後にヒッププロテクターについて述べる。この手段は介護現場で使用されるもので、これまで記述したような介入を外来通院で続けることが可能な自立度を保持している高齢者には、情報としてヒッププロテクターの説明はするが、その実際の適応は少ない。逆に、施設入所レベルの要介護高齢者でまだ寝たきりにはなってい

ない者は、転倒・骨折リスクが極めて高いにもかかわらず、骨粗鬆症治療や転倒予防介入で対応できない、あるいは間に合わないことが少なくなく、その場合はヒッププロテクターの使用が可能となる。本人任せにせず、介護者が協力してコンプライアンスさえ保てば大腿骨頸部骨折の半減を期待できる<sup>8)</sup>。

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## VIDEOFLUOROGRAPHIC OBSERVATIONS ON SWALLOWING IN PATIENTS WITH DYSPHAGIA DUE TO NEURODEGENERATIVE DISEASES

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### ABSTRACT

We examined three intervention methods for their efficacy in preventing aspiration in 25 patients with Parkinson's disease (PD) and 23 patients with degenerative cerebellar ataxia (CA). On videofluoroscopic examination, 13 patients with PD (52%) and 7 patients with CA (30.4%) showed aspiration. In all PD patients and 5 patients with CA, no aspiration was observed after changing the food form. With the chin down posture and supraglottic swallow techniques, no aspiration was observed in only 1 PD patient. Among 7 patients with CA, the chin down posture and supraglottic swallow techniques resulted in the disappearance of aspiration in 4 patients. This indicates that changing the food form (ex. jelly) was effective in preventing aspiration in both PD and CA patients with a history of aspiration. In addition, the chin down posture and supraglottic swallow techniques were effective in preventing aspiration in CA patients with good sitting-position balance and cervical control.

Key Words: Parkinson's disease, degenerative cerebellar ataxia, dysphagia, videofluorography, swallowing training

### INTRODUCTION

In patients with degenerative cerebellar ataxia (CA) and Parkinson's disease (PD), dysphagia with aspiration often occurs, causing aspiration pneumonia in some patients. For prevention, it is important to clarify the pathogenesis of dysphagia. Rehabilitation techniques such as the chin down posture, the supraglottic swallow, and the use of jelly are expected to be effective for patients with a history of aspiration. In the supraglottic swallow technique<sup>1,2</sup>, patients voluntarily protect their airway by holding their breath while swallowing, and then exhaling after swallowing. Bushmann reported the supraglottic swallow was successful in eliminating aspiration in 2 of 3 PD patients with aspiration<sup>3</sup>. The chin down posture technique protects the airway by flexion of the neck when swallowing. No studies have examined the effect of therapeutic procedures in preventing aspiration in CA patients. Therefore, it is unclear whether these three interventions may prevent aspiration in patients with neurodegenerative disease. In the present study, we investigated the characteristics of dysphagia using videofluoroscopic examination (VF examination<sup>4</sup>) in patients with CA or PD, and examined the effects of the chin down posture, the supraglottic swallow, and the use of jelly as aspiration prevention methods in patients with a history of aspiration.

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## SUBJECTS

Twenty five patients (12 men, 13 women) with PD and 23 patients with CA (9 men, 14 women) who had dysphagia were studied. All subjects were referred to the department of rehabilitation for dysphagia evaluation. The PD patients ranged in age from 52 to 86 years (mean $\pm$ SD: 70.2 $\pm$ 9.1 years). Their illness duration ranged from 5 to 33 years (mean $\pm$ SD: 10.4 $\pm$ 7.0 years). According to the Hoehn and Yahr disability scale<sup>5)</sup>, 12 patients were at stage 3; 4 were at stage 4; and 9 were at stage 5. Patients with severe dementia, depression, or other disorders interfering with swallowing or pulmonary function were excluded. All patients had the communicative and cognitive functions necessary to perform the chin down posture and supra-glottic swallow techniques. The CA patients ranged in age from 29 to 69 years (mean $\pm$ SD: 56.7 $\pm$ 13.3 years). The disease duration ranged from 1 to 22 years (mean $\pm$ SD: 6.7 $\pm$ 4.7 years). The types of CA included 9 patients with multiple system atrophy (MSA), 3 patients with Machado-Joseph disease (MJD), 1 patients with sporadic spinocerebellar ataxia (SCA2), 2 patients with hereditary spinocerebellar ataxia (hereditary SCA) (not yet confirmed in molecular genetics), 5 patients with hereditary cortical cerebellar atrophy (hereditary CCA), and 3 patients with sporadic CCA. Informed consent was obtained from all subjects.

## METHODS

To assess swallowing function, a modified barium swallow study<sup>4)</sup> was performed using Iopamidol (equivalent to 300 mg of organic iodine per ml) which was diluted 2 – fold with sugar water or mixed with jelly. In PD patients, all examinations were performed 90–120 min after the first afternoon dose of levodopa. The subjects were instructed to hold the contrast medium placed in the mouth until the command to swallow was given, then to swallow naturally in a vertical sitting position. After instructions were given, 5, 7, or 10 ml of the contrast medium were placed in the subject's mouth using a cup, and jelly containing the contrast medium was placed in the mouth with a teaspoon. Imaging during the fluorography was recorded on a videotape running at 30 frames/sec, using a videocassette recorder (Toshiba, AE52C) coupled to a counter-timer that placed timing information on each video field<sup>6)</sup>. Just before the command to swallow, the fluoroscope was activated. The command to swallow was immediately given and the subject swallowed the contrast medium. The subject performed 2 swallows of both the liquid and the jelly containing the contrast medium. The videotapes were analyzed frame-by-frame in slow motion to identify abnormalities in swallowing. Abnormal findings in the oral and pharyngeal phases were recorded as residue of the contrast medium in the anterior and lateral sulci, uncontrolled bolus or premature swallow, piecemeal deglutition, vallecular residue of the contrast medium, residue of the contrast medium in the pyriform sinuses, and the presence or absence of aspiration. Residue of the contrast medium in the anterior and lateral sulci was defined as the contrast medium falling and lodging in the anterior and lateral sulci after swallowing<sup>4)</sup>. Uncontrolled bolus or premature swallow was defined as a premature loss of liquid or jelly into the pharynx<sup>4)</sup>. Piecemeal deglutition was defined as two, three, or more repeat swallows to empty the oral cavity because the subject swallowed only one piece of the bolus at a time<sup>4)</sup>. Residue of the contrast medium in the pyriform sinuses was defined as any stasis or residue of the contrast medium lodging in the pyriform sinuses after swallowing<sup>4)</sup>. Aspiration was defined as entry of the contrast medium into the airway below the vocal folds<sup>4)</sup>. When aspiration was observed by VF examination, the chin down posture and supra-glottic swallow techniques were performed to examine whether aspiration disappeared. To test the interrater

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reliability of the abnormal findings, each recording during the fluorography was evaluated by two independent readers, one of whom was blind to the patient's diagnosis and age. For interrater reliability, we used the kappa statistic for comparison of nominal data<sup>7,8)</sup>.

## RESULTS

Twenty one patients with PD showed abnormalities in the oral phase of swallowing. Findings included residue of the contrast medium in the anterior and lateral sulci in 5 patients, uncontrolled bolus or premature swallow in 16 patients, and piecemeal deglutition to the pharynx in 20 patients (Table 1). In the pharyngeal phase, 20 patients showed abnormalities. Findings included vallecular residue of the contrast medium in 17 patients, residue of the contrast medium in the pyriform sinuses in 13 patients, and aspiration in 13 patients. In the 13 patients with aspiration, no aspiration was observed when they swallowed jelly. Only 6 of these 13 patients were able to perform the chin down posture and supraglottic swallow techniques. No aspiration was observed while swallowing liquid in only 1 patient.

Thirteen patients with CA showed abnormalities in the oral phase. Findings included residual contrast medium in the anterior and lateral sulci in 2 patients, uncontrolled bolus or premature swallow in 9 patients, and piecemeal deglutition to the pharynx in 9 patients (Table 2). Eleven patients showed abnormalities in the pharyngeal phase, which included vallecular residue of the contrast medium in 8 patients, residue of the contrast medium in the pyriform sinuses in 5 patients, and aspiration in 7 patients. The seven patients were instructed to swallow jelly. In 5 of 7 patients, no aspiration was observed. Six of 7 patients were able to perform the chin down posture and supraglottic swallow techniques, and aspiration disappeared in 4 of the patients.

Interrater reliability was assessed for 48 different observations of the videofluorography (table 3). For the eight variables, the kappa agreement coefficient revealed high interrater reliability in assessing the videofluorography.

## DISCUSSION

Among neurodegenerative diseases, PD and CA often cause dysphagia with aspiration. In the present study, we evaluated dysphagia in patients with PD or CA by VF examination, and examined whether aspiration disappeared when the patients swallowed jelly containing the contrast medium, or when rehabilitation techniques such as the chin down posture and supraglottic swallow were performed.

In the present study, a variety of swallowing abnormalities in the oral and pharyngeal phase were observed in PD or CA patients with dysphagia. Veis<sup>9)</sup> reported that 38 patients with cerebrovascular accident exhibited a variety of physiologic disturbances in VF examination. A delayed swallowing reflex was the most frequent disorder, and reduced pharyngeal peristalsis was the next frequent disorder, followed by reduced tongue control. But our VF examinations and subsequent observations performed on patients with PD or CA. The incidence of videofluorographic abnormal findings in PD patients was larger than that in CA patients. As for activities of daily living (ADL), the mean value of Barthel Index in PD patients was lower than that in CA patients. In the present study, physical function in PD patients was more impaired than that in CA. Therefore, the incidence of VF abnormal findings in PD patients was greater.

Several studies have reported the effects of head and neck positions on swallowing. Postures that compensate for swallowing include the chin down posture, head back posture, head tilt

Table 1 Videofluorographic findings in patients with Parkinson's disease

Case	Sex/ Age (yrs)	Stage	Course (yrs)	Residue in the anterior and lateral sulci	Uncontrolled bolus/ premature swallow	Piecemeal deglutition	Vallecular residue after swallow	Residue in pyriform sinuses	Aspiration	jelly effect	chin down	supraglottic swallow
1	F/53	3	8	-	-	-	+	+	+	E	E	E
2	F/76	3	6	-	+	+	+	+	+	E	NE	NE
3	F/77	3	7	-	+	+	+	-	+	E	NE	NE
4	M/73	3	33	-	+	+	-	-	+	E	NE	NE
5	F/67	4	11	+	+	+	+	+	+	E	NE	NE
6	F/71	4	12	+	+	+	+	+	+	E	NE	NE
7	M/52	5	14	+	+	+	+	-	+	E	ND	ND
8	M/69	5	7	-	+	+	+	+	+	E	ND	ND
9	M/70	5	5	-	+	+	-	-	+	E	ND	ND
10	M/73	5	26	+	+	+	+	+	+	E	ND	ND
11	M/79	5	8	-	-	-	+	+	+	E	ND	ND
12	F/79	5	10	-	+	+	+	+	+	E	ND	ND
13	M/81	5	13	-	+	+	+	+	+	E	ND	ND
14	M/54	3	9	-	+	+	+	+	-	-	-	-
15	M/57	3	8	-	-	+	+	-	-	-	-	-
16	F/66	3	4	-	-	+	+	+	-	-	-	-
17	F/67	3	6	-	-	-	+	-	-	-	-	-
18	F/69	3	7	-	-	-	+	-	-	-	-	-
19	M/71	3	5	-	+	+	+	+	-	-	-	-
20	M/75	3	5	-	+	-	-	-	-	-	-	-
21	M/84	3	8	-	-	+	-	-	-	-	-	-
22	F/64	4	8	-	-	+	-	-	-	-	-	-
23	F/73	4	14	-	+	+	+	-	-	-	-	-
24	F/69	5	5	-	-	+	-	-	-	-	-	-
25	F/86	5	21	+	+	+	-	+	-	-	-	-

E: effective, NE: not effective, ND: could not be performed.