養量の設定については、食事摂取基準の策定根拠や虚弱高齢者における特徴を考慮して検討する必要があります。高齢者における推定エネルギー必要量は、食事摂取基準では、基礎代謝量に身体活動レベルを乗じることで求められています。高齢者における基礎代謝基準値は、2010年版では値の変更はなく、70歳以上では男性で21・5kcal／kg／日、女性で20・7kcal／kg／日とされています。虚弱高齢者のエネルギー必要量に関する研究をまとめたGaillardらのレビューでは、健康な高齢者における安静時代謝量（resting metabolic rate:RMR）は19・4kcal／kg／日で、疾病を有する高齢者での20・4（18・5～22・2）kcal／kg／日と差がないとしています。しかし、低体重の者では24・9kcal／kg／日、90歳を超える高齢者では23・8kcal／kg／日と高くなることが示されました。体重当たりのRMRは、BMIが低いほど高くなるため、低体重者においては、基礎代謝基準値に体重を乗じた値が、基礎代謝量を過小に推定している可能性があります。

身体活動レベルについては、2010年版の食事摂取基準では、70歳以上の値が大きく変更されました。これは2005年版における身体活動レベルの検討以降に、健康で自立した高齢者を対象とした報告が数多く出され、それらの平均値が1・69であったことによります。そのため、70歳以上における身体活動レベルは、2005年版では「低い」、「ふつう」、「高い」において、1・30、1・50、1・70であったのが、1・45、1・70、1・95と高くなっています。しかし、2010年版で使用されている研究の多くは、70～75歳で比較的健康で自由な生活を営んでいる人を対象としています。90歳代を対象としたRothenbergらの研究では、身体活動レベルは女性で1・19、男性で1・36と低い値が報告されています。また、Gaillardらのレビューによれば、患者、低体重者、超高齢者の身体活動レベルは食事摂取基準における「低い」（1・45）よりもさらに低い1.2～1.4程度の間にあると考えられています。

たんぱく質については、高齢者において利用効率が成人と異なるかについて十分な根拠はありません。食事摂取基準2010年版では、高齢者を対象とした研究結果をもとに、体重あたりの推定平均必要量は0・85g／kg／日とされ、成人における0・72／kg／日よりも高い値となりました。施設入居者では、窒素出納が負を示す者が少なくないことが海老沢らにより報告されています。これは、身体活動量の低下に伴い骨格筋のたんぱく質代謝が低下すること、窒素出納はエネルギー摂取量の影響を大きく受けることにより ます。エネルギー摂取量が500kcal不足

表1　低栄養の問題の背景

良好な栄養状態を維持する要素
・食べようという動機づけがある。 ・食材を調達する能力がある。 ・食事を用意する（料理する）ことができる。 ・食事を摂取することができる。 ・エネルギー所要量と栄養素（ミネラル、ビタミン、たんぱく質）の点で摂取した食事が適切である。
栄養状態の問題
・エネルギーの摂取不足 ・たんぱく質の摂取不足 ・1つ以上の栄養素の摂取不足 ・エネルギーの過剰摂取
栄養問題
・慢性疾患や薬物療法によって、食欲や食べようという動機づけが減退している。 ・食べ物のにおいや味がわからなくなったり、一緒に食べる人がいないために、食べる楽しみが減っている。 ・衰弱性の疾患のため、あるいは買い物に行くことができない、家計が苦しいなどの理由によって、食材が調達できない。 ・認知や身体機能の障害、あるいは台所の環境が適切でないために、調理ができない ・認知、視覚、手先の器用さ、口の疾患、嚥下の問題によって、食物を摂取することができない

（MDS-HC 2.0在宅ケアアセスメントマニュアル、医学書院、2004より作図）

すると、たんぱく質必要量を約3g増加させる必要があると推定されます。これらのことから検討すると、介護予防を目的とした場合に、第一には身体活動量の増加、十分なエネルギー摂取ができるように食事摂取量を増加しながら、たんぱく質の摂取量に配慮することが必要と考えます。表1には、低栄養の背景となり得る状況についてポイントを示しました。

脱水予防

1. 脱水の問題点

人体は約63%の水分を含んでいますが、その多くは除脂肪部分に含まれています。高齢者においては、筋肉量や骨量の低下に伴う除脂肪量の低下が認められており、また、口渇感の減少や腎機能の低下などによる水分代謝への影響があります。とくに高齢者の場合、食事摂取量の減少による食品からの水分摂取量の減少、失禁・夜間排尿への不安あるいは介助者への遠慮から水分摂取量を減らしがちであり、脱水のリスクは成人より高いと考えられます。脱水は重症になると、精神的な錯乱や身体機能の低下、皮膚の損傷、感染症や転倒を起こしやすくします。

表2　高齢者における脱水のリスクファクター

- 85歳以上
- 口渇感の低下
- 飲み物を得ることへの障害
- コミュニケーションの障害
- 認知機能低下
- 嚥下機能低下
- 食欲低下
- 投薬（利尿剤、緩下剤、鎮静剤など）
- 急性疾患（発熱、嘔吐、下痢など）
- 介護者の注意不足

(Ferry M, 2005)

表3　脱水予防のステップ

- 情報提供と教育を介護者と医療関係者に行う
- 高齢者自身に口渇感がなくても水分をとるように指導する
- ハイリスクの高齢者を特定する
- 高齢者が飲み物を得ることができるかを確認する
- 高齢者に水分を取るようにすすめる
- 脱水を起こすような投薬を長期に続けているか確認する
- 食欲不振があるかを確認する
- 飲むことに障害を与えるような環境要因がないかを確認する

(Ferry M, 2005)

2．脱水の現状

水分の量が不足すると汗をかきにくくなり、熱中症を発症することがあります。消防庁による２００８年８月の熱中症における救急搬送状況の報告をみると、１ヵ月間に全国で熱中症による救急搬送は８８５７件ありましたが、そのうち65歳以上の高齢者は３５００件で39・５％を占めていました。高齢者の人口構成割合の22・０％から比べると、熱中症による搬送は高齢者に多いといえます。

脱水については、長沼らのデイサービスに通所する在宅要介護高齢者を対象とした調査によると、「脱水の疑い」と判定された者は152名中18・４％で、性・年齢・要介護度別に差はみられませんでした。

3．脱水予防の対応

水分摂取量の過不足を評価することは難しいものです。口渇感は、体の水分量がある程度低下してからしか起きず、日常で水分出納をとるための指標とはなりにくく、とくに高齢者では、口渇感の低下から水分不足の指標にはなりにくいのです。スポーツ選手等では、発汗時の水分補給状態の指標として、体重の変化がしばしば使用されます。しかし高齢者では、慢性的な水分摂取不足状態にある場合があること、低栄養によ

る体重変化の可能性もあることから、体重を水分摂取量の過不足の評価に用いにくいのが現状です。尿量、尿の浸透圧、尿の比重などが体の水分状態の指標となりますが、日々の評価には適していません。1994年頃からスポーツ選手において、尿の色見本を使用した水分の充足度の評価が試みられています。Mentesらは、施設入所の高齢者における尿の色見本による評価を試み、色見本での評価と比重の相関が高く、今後、水分摂取の充足度を定期的に評価する際の指標になる可能性を示しました。しかし使用に際しては、尿の色が薬物、食物、とくにビタミンB群の摂取の影響を受けることを考慮しなければなりません。

水分は食物と飲み物から摂取され、どちらも把握することが難しいものです。長沼らの調査では、1日の飲水量（食事以外）は平均で1146・8mlで加齢とともに減少する傾向にありました。食物からの摂取量は通常1000mlと仮定されていますが、高齢者ではおそらく600～700mlに減少していると推定されています。脱水を予防する方法としては、まず脱水を起こす可能性のあるハイリスクな高齢者（表2）を確認することが重要です。そのうえで、表3に示すような注意が必要でしょう。

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Tooth loss as risk factor for foreign-body asphyxiation in nursing-home patients

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ABSTRACT

Foreign body asphyxiation causes severe medical conditions including pneumonia in the elderly requiring nursing care. The objective of this study was to elucidate the relationships between insufficient occlusal support due to tooth loss and the onset of asphyxiation accidents, and determine preventive measures for such accidents in nursing homes in Japan. The subjects were 437 elderly (110 men and 327 women) requiring nursing care. The frequency and risk factors for asphyxiation accidents and the food causing asphyxiation were examined in these subjects for 2.5 years, from June 2006 to December 2008. During the study period, 51 of the 437 subjects suffered asphyxiation. Self-feeding ability and loss of occlusal support were associated with a covariate-adjusted relative ratio for asphyxiation of 3.1 (95% confidence interval (CI) = 1.50–6.44) and 1.7 (95% CI = 1.12–2.74), respectively. To prevent asphyxiation in elderly people, it was found that maintaining or restoring occlusal support may be required. It was concluded that self-feeding ability and loss of occlusal support are significant risk factors for foreign-body asphyxiation among elderly people requiring nursing care.

1. Introduction

Asphyxiation occurs when any object is aspirated into the larynx or tracheobronchial tree, and causes airway obstruction: this obstruction can result in inability to breathe, with the need for rapid intervention to prevent asphyxial death (Ekberg and Feinberg, 1992). Therefore, asphyxiation cases are identified by signs and symptoms of dyspnea, abnormal respiratory rate, rhythm/depth of breathing, restlessness and cyanosis. Asphyxia is reported to be a common cause of death not only in the general population (Feinberg et al., 1992), but also in infants (<1 year of age) and the elderly. To date, a high frequency (incidence: 0.66 fatalities/100,000) of asphyxia has been reported in the general population each year (Fioritti et al., 1997). In Japan, deaths from asphyxiation have increased since the 1980s. Moreover, the mortality from asphyxiation incidents in infants has decreased by more than 60% in the past 30 years. However, mortality from asphyxiation in the elderly has increased rapidly (Ichikawa and Marui, 2000). This represents an important warning regarding asphyxiation to both elderly receiving care and their caregivers.

Samuels and Chadwick (2006) reported rapid eating, cramming of food into the mouth, and premature transfer of food into the pharynx as possible causes of asphyxiation in the elderly. Several reports have also suggested that oral stage dysfunction and cognitive impairment contribute to asphyxiation (Carter and Jancar, 1984; Feinberg et al., 1992; Finestone et al., 1998). A huge number of elderly people, including those requiring nursing care, lose teeth and/or occlusal support, resulting in decreased oral function (Hatch et al., 2001). Since wearing dentures is related to oral function, speech function and independent activities of daily living (Minakuchi et al., 2006), elderly people who lose occlusal support must wear dentures. However, it is sometimes difficult for elderly people requiring nursing care to wear dentures, for many reasons including mismanagement of dentures, losing dentures, and shortage of oral-care services. There have been few reports on the relationship between asphyxiation accidents and insufficient occlusal support due to tooth loss or failure to restore occlusal support by means of dentures. Haddon suggested that it is possible to eliminate these risk factors related to accidental death. Even when accidents do occur, the worst outcome can be avoided by thorough application of appropriate measures during and after an accident (Haddon, 1980).

In the present study, we examined the risk factors for asphyxiation accidents among the elderly in nursing homes, and determined the relationships among insufficient occlusal support caused by tooth loss, restoration of occlusal support by means of dentures, and asphyxiation accidents.

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2. Materials and methods

2.1. Participants

The survey was conducted in 486 individuals (mean age: 85.0 ± 8.5 years), whose guardians gave consent to their participation in the present study, among elderly people requiring care in 13 nursing homes in Japan. Of them, those who were discharged from nursing homes ($n = 49$) because of other reasons than asphyxiation were excluded from this study, since we could no longer peruse them. The study was performed on 437 subjects (110 men and 327 women; mean age, 80.8 ± 8.3 years for men and 86.4 ± 8.1 years for women; Barthel index, 25.1 ± 25.0).

2.2. Survey of asphyxiation

Asphyxiation occurring while eating food over a period of 2 years and 6 months from June 2006 to December 2008 was examined, and the outcomes were also determined. In this study, asphyxiation accidents were limited to those caused by food.

Asphyxiation cases were identified by signs and symptoms such as dyspnea, abnormal respiratory rate, rhythm/depth of breathing, restlessness and cyanosis as reported by the North American Nursing Diagnosis Association (2003).

2.3. Examination of risk factors for asphyxiation

The following six items were assessed to examine the risk factors for asphyxiation. In terms of the oral environment and oral function, the procedures used by dentists and physicians in each nursing home were studied.

2.3.1. Self-feeding ability

Subjects who could feed themselves at least partly without any help were assigned to the "independent group" and those who were able to eat only with assistance were assigned to the "dependent group".

2.3.2. Activity of daily living (ADL)

ADL in these subjects was evaluated using the Barthel Index (Mahoney and Barthel, 1965). When the index was 45 points or higher, ADL was considered to be maintained, and when the index was less than 40 points, ADL was considered to be decreased.

2.3.3. Cognitive function

The severity of senile dementia was evaluated according to "ADL independence of demented elderly", designed by the Ministry of Health, Labour and Welfare of Japan (http://www.mhlw.go.jp:80/topics/kaigo/kentou/15kourei/sankou4.html; Hirakawa et al., 2008). Cognitive impairment was identified at rank 2 and higher of this scale (Table 1).

2.3.4. Tongue coating

Tongue coating was visually evaluated according to the report by Miyazaki et al. (1995). We divided the scores into two groups (no, score 0 and 1; yes, score 2 and 3).

2.3.5. Food residue

We assessed food residue in the oral region after a meal (Ono et al., 2007).

2.3.6. Xerostomia

The presence or absence of xerostomia was examined. The categories reported by Kakinoki et al. (2004) were dry, mildly dry, wet (normal) and wet (high). The categories of dry and mildly dry were considered to indicate xerostomia.

Table 1
ADL independence of demented elderly (Ministry of Health, Labour and Welfare of Japan).

Rating criteria	Description
Rank 0	Clear mentality
Rank 1	Although demented, the subject is almost independent in ADL at home or elsewhere
Rank 2	The subject shows slight impairment of cognition, but is independent under a carer's observation
Rank 3	The subject sometimes shows impairment of cognition, thus a carer is required
Rank 4	The subject often shows impairment of cognition, thus a carer is required all time
Rank 5	The subject shows serious mental symptoms or problematic behavior, thus specific medical care is required

2.4. Assessment of oral function

Assessment of oral function was performed based on the current number of teeth, occlusal condition and presence or absence of swallowing disorder.

2.4.1. Assessment of occlusal condition

With regard to the occlusal condition, the Eichner classification of occlusal support regions (Eichner, 1955) was used for reference. Subjects with an Eichner occlusal support classification of A1–B1, who had occlusal support in at least three sites in the molars, were assigned to the "natural occlusal support group". Those in whom occlusal support was restored with removable dentures were assigned to the "denture occlusal support group". Those with occlusal support in two or fewer sites with an Eichner classification of B2–C3, with no occlusal support in the molars, and unrestorable occlusal support using removable dentures were assigned to the "occlusal support disruption group".

2.4.2. Swallowing disorder

Swallowing disorder was defined as cases in which choking or accidental aspiration occurred, and cases that showed a gurgling sound on auscultation of the neck region (Takahashi et al., 1994) after swallowing 3 ml of water.

2.5. Survey of diagnosis

The presence or absence of general conditions that might have affected swallowing function was determined.

2.6. Survey of concomitant medication

Medication that might have affected oropharyngeal function (e.g., psychotropic agents, antidepressants) (Carl and Johnson, 2006) was investigated.

2.7. Statistical analysis

Chi-squared test was used to determine the independence of each group in two-group comparisons. Risk factors were screened by logistic analysis of variance using the presence or absence of a history of asphyxiation as a dependent variable and the presence of significant factors as an independent variable. The stepwise method (backward elimination method) was used for variable selection. Windows Japanese version SPSS (Ver. 16) was used for statistical analysis, and the level of significance was a p value of <0.05.

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Table 2
Univariate analysis of subjects' demographics.

		Asphyxiation ($n=51$)	No asphyxiation ($n=386$)	Relative risk (95% CI)	p value
Sex	Male	10	100	1.43 (0.69–2.97)	0.21
	Female	41	286		
Self feeding	Independent	41	209	3.47 (1.69–7.13)	<0.001
	Dependent	10	177		
ADL	Maintained	34	312	2.11 (1.12–3.98)	0.02
	Decreased	17	74		
Cognitive function	Maintained	28	117	2.80 (1.55–5.06)	<0.001
	Decreased	23	269		
Tongue coating	Yes	20	135	1.20 (0.66–2.19)	0.55
	No	31	251		
Food residue	Yes	20	157	0.93 (0.51–1.69)	0.32
	No	31	222		
Xerostomia	Yes	15	132	0.80 (0.42–1.52)	0.44
	No	36	254		
Occlusal support	Natural occlusal support	5	83		
	Denture occlusal support	16	153		0.02
	Occlusal support disruption	30	150		
Swallowing disorder	Yes	27	124	2.38 (1.32–4.29)	0.03
	No	24	262		
Previous stroke	Yes	19	212	0.72 (0.40–1.32)	0.18
	No	32	174		
Drug administration	Yes	16	110	1.15 (0.61–2.16)	0.39
	No	35	276		

3. Results

3.1. Incidence of asphyxiation

Fifty-one subjects suffered asphyxiation due to food (10 men and 41 women; mean age, 85.6 ± 7.1 years). The annual incidence of asphyxiation accidents was 4.7%. Four subjects had two or more episodes of asphyxiation during the period (four times: one subject, three times: two subjects, two times: one subject). Death caused by asphyxiation occurred in two subjects.

The food causing asphyxiation was fruit in seven subjects, vegetables in four, meat in four, fish in four, rice in three, bread in one, and others in six. There were 29 unclear cases where several foods were involved. There could be multiple causes in those subjects. After the onset of asphyxiation, 13 subjects (25.5%) were transferred to an emergency clinic or hospitalized, but two of them died in hospital within 24 h.

3.2. Risk factors

Factors showing a significant relationship with the onset of asphyxiation were self-feeding [$p < 0.001$, relative risk = 3.47 (1.691–7.131)], ADL [$p = 0.02$, relative risk = 2.11 (1.12–3.98)], and cognitive function [$p < 0.001$, relative risk = 2.80 (1.55–5.06)]. Among 180 subjects who had lost occlusal support with their natural teeth and did not regain occlusion, 30 subjects (16.7%) suffered asphyxiation. However, among 169 subjects whose occlusal support was restored with dentures, 16 subjects (9.5%) suffered asphyxiation, and among 88 subjects with occlusal support with their natural teeth, 5 subjects (5.7%) suffered asphyxiation. The incidence of asphyxiation showed a significant difference ($p = 0.016$) among the three groups (Table 2) (Fig. 1).

3.3. Survey of diagnosis

The presence or absence of general conditions that might have affected swallowing function was determined, and found out that none of them had affected swallowing function (Table 3).

3.4. Results of logistic analysis

Risk factors were screened by logistic analysis of variance using the presence or absence of a history of asphyxiation as a dependent variable and the presence of significant factors in univariate analysis as an independent variable. The stepwise method (backward elimination method) was used for variable selection. As a result, "self-feeding" ($p < 0.001$, relative risk = 3.11, 95% CI:

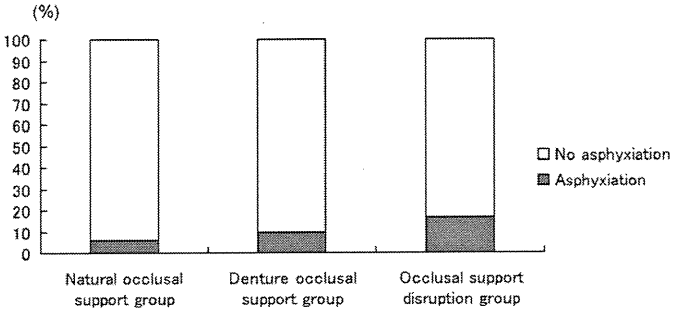

Fig. 1. Relationship between dental status and incidence of asphyxiation. Among 171 subjects who had lost occlusal support with their natural teeth and did not regain occlusion with dentures, 30 subjects (17.5%) suffered asphyxiation. Among 215 subjects whose occlusal support was restored by means of dentures, 21 subjects (9.8%) suffered asphyxiation. Among 113 subjects with occlusal support with their natural teeth, 5 subjects (4.4%) suffered asphyxiation ($p = 0.016$, chi-squared test).

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Table 3
Univariate analysis of subjects' general conditions.

		Asphyxiation (n=51)	No asphyxiation (n=386)	Relative risk (95% CI)	p value
Cerebrovascular disease	Yes	19	212	0.72 (0.40–1.32)	0.180
	No	32	174		
Neuromuscular disease	Yes	5	25	1.57 (0.57–4.30)	0.264
	No	46	361		
Cardiac disease	Yes	4	48	0.60 (0.21–1.74)	0.242
	No	47	338		
Respiratory disease	Yes	4	18	1.74 (0.57–5.36)	0.247
	No	47	368		
Diabetes	Yes	1	5	1.52 (0.17–13.31)	0.527
	No	50	381		
Bone and joint disease	Yes	16	97	1.36 (0.72–2.57)	0.395
	No	35	289		

1.50–6.44) and "occlusal support" (p = 0.01, relative risk = 1.75, 95% CI: 1.12–2.73) were selected as significant explanatory variables (Table 4).

4. Discussion

The annual incidence per capita of asphyxiation accidents in the present study was 4.7 per 1000 population in Japan; this is lower than the results from previous research carried out at day-care facilities for elderly people (Takahashi et al., 1994). The incidence of asphyxiation among elderly people in care facilities for the aged was clearly higher than that of elderly people living at home. The elderly people in care facilities appeared to be frailer than those who received care at home. Although the frequency was generally low, accidents were often fatal. Our results show that many individuals were hospitalized after asphyxiation accidents and some of them died. Among the subjects with asphyxiation, approximately 8% had several asphyxiation episodes during the study period, which is four times higher than that reported previously (Suda et al., 2008). Those who suffered several asphyxiation accidents were considered to be at higher risk of death.

We demonstrated that factors related to asphyxiation accidents include self-feeding, ADL, cognitive function, occlusal support of molars, and swallowing disorders. Of these, there was a strong correlation between occlusal support of molars and the incidence of asphyxiation. Many elderly people lose their teeth because of dental caries or periodontal disease, and many of those in the present study had lost occlusal support with their natural teeth. This may lead to reduced chewing ability in elderly people (Hatch et al., 2001). However, the rate of use of dentures, especially among frail individuals, is known to be low. The ability to use dentures is reduced by impaired cognitive function, apraxia, and spatial cognition disorders and is known to be affected by a decrease in ADL (Carter and Jancar, 1984).

We demonstrated that cognitive function is one of the risk factors for asphyxiation. In elderly people with reduced cognitive function requiring nursing care, it has been reported that swallowing without chewing as well as cramming food into the mouth often occurs (Samuels and Chadwick, 2006). These people have also been reported to show symptoms of fast-eating syndrome (Bazemore et al., 1991). In fact, many elderly people with dementia die because of accidental swallowing or asphyxiation (Brunnström and Englund, 2009). In comparison with patients with cerebrovascular dementia, patients with frontotemporal dementia are known to have abnormal eating habits, including cramming food and eating fast (Bathgate et al., 2001), which makes it necessary to take measures to prevent asphyxiation in accordance with the type of dementia.

It is interesting that the incidence of asphyxiation showed a strong association with the ability to self-feed. The ability to understand the use of eating utensils, a sufficient range of arm motion, and coordination of both arms and oral function are necessary for self-feeding. Good management of self-feeding ability is an important factor in maintaining quality of life of the elderly. According to Volicer et al. (1987), (50)% of patients with Alzheimer disease lose the ability to self-feed within 8 years after diagnosis. Apraxia and spatial-cognitive disorders cause problems in self-feeding ability. Many diseases associated with dementia are considered to impair self-feeding ability. To improve or maintain self-feeding ability, it is necessary to undertake very complex measures based on an understanding of one's own chewing function and swallowing function, and on selection of food in accordance with those functions. If selection of food is necessary, reprocessing of food could be undertaken such as by subdividing, cutting or mixing, to make the food match the functions mentioned above. Every individual must consider the pace of eating by coordinating the amount of food in each bite to prevent accidents.

The results of this study suggest that absence of occlusal support is a risk factor for asphyxiation. Individuals who had lost occlusal support with their natural teeth showed a higher risk of asphyxiation than those with occlusal support. These results suggest that restoration of occlusal support with dentures might be an effective procedure to prevent asphyxiation. If dentists undertook measures based on continuous dental management for frail elderly people, more people might become able to wear dentures (Kawana et al., 2010). Prevention of dental caries and periodontal diseases that cause tooth loss is, of course, essential to prevent loss of occlusal support, and should be included in the management plan. Maintenance of occlusal support for frail elderly people by means of continuous management by dentists is also effective to prevent asphyxiation.

To further prevent asphyxiation and eat safely in elderly people with little ability to control the speed and amount of food, it is important to assist such people while taking food, rather than encourage them to improve their self-feeding ability.

Table 4
Independent predictors of asphyxiation.

	Coefficient (±S.E.)	p value	Relative risk	95% CI	
				Lower	Upper
Self feeding	1.13 (±0.37)	<0.001	3.11	1.50	6.44
Occlusal support	0.56 (±0.23)	0.01	1.75	1.12	2.73

S.E.: standard error.

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Conflict of interest statement

None.

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Videoendoscopic assessment of swallowing function to predict the future incidence of pneumonia of the elderly

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SUMMARY **The purpose of the present study was to examine what dysphagic signs identified by videoendoscopy (VE) could predict the incidence of pneumonia and body weight loss in elderly patients living in nursing homes. This study was performed at six nursing care facilities in Japan from March 2007 to February 2009. The 148 subjects (85·1 ± 8·0 years, male/female: 43/105) were evaluated for their feeding and swallowing movements by clinical and VE examinations during the consumption of a regular meal. The VE examination items included the existence/absence of pharyngeal residue, laryngeal penetration, and aspiration of food and saliva. The patients were followed-up for 3 months with individualized feeding therapy based on the results of the clinical/VE examination at baseline, and the incidence of pneumonia was examined as the primary outcome. In patients without pneumonia, the body weight change was also measured as a secondary outcome. The risk factors for pneumonia and body weight loss (of 3% or more) were identified among the clinical/VE examination items by a Cox proportional hazard analysis. Even with elaborative feeding therapy, 12 (8·1%) of the 148 patients developed pneumonia during the 3 months follow-up period. The existence of signs of 'silent aspiration of saliva' or 'aspiration of saliva' detected by VE examination was a significant risk factor for both pneumonia and a body weight loss of 3% or more. This study shows that 'aspiration of saliva' detected by VE is a significant risk factor for both pneumonia and body weight loss in elderly patients living in nursing homes.**

KEYWORDS: **videoendoscopy, aspiration-related pneumonia, dysphagia, aspiration of saliva, body weight loss**

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Introduction

Dependent elderly patients are at high risk for feeding and swallowing disorders as a consequence of disease and/or aging (1–3). Studies done in long-term care facilities have shown a prevalence of such disorders ranging from 60% to 87% (4, 5). Among the various disorders, special attention has been given to dysphagia because it may lead to malnutrition with immune system compromise, dehydration, asphyxiation, or even aspiration pneumonia (1–3). Moreover, a previous follow-up study of patients with dysphagia in such care facilities revealed an incidence of pneumonia of 43% and a mortality rate of 45% at 1 year following the detection of their swallowing disorder (6). Therefore, clinicians should be able to identify dysphagia in order to predict those patients at risk of developing complications secondary to dysphagia, as well as to develop and implement a rehabilitation plan stressing prevention and compensation.

Videofluorography (VF) has been regarded as the most popular adjunctive instrument for the

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examination of patients with suspected oropharyngeal dysphagia. Previous studies have examined the use of VF as a means to predict those at risk for dysphagia and its complications (7, 8). For instance, Mann *et al.* (7) found that the single best independent predictor for chest infection following an acute stroke was a delayed or absent swallowing response in acute stroke patients. Teraoka *et al.* (8) found that the single best predictor of oral intake in post-stroke patients with dysphagia was the presence of aspiration detected by VF assessment. Nevertheless, one major disadvantage of VF for patients living in long-term care facilities is that the patients need to be transported to a hospital setting, which is sometimes inconvenient or may disorientate the patient because of the sudden change in the environment. Other disadvantages are related to the exposure to X-ray radiation and the risk of aspiration during VF assessment in some patients with severe physical or mental alterations (9).

On the other hand, videoendoscopic (VE) examination of swallowing allows for easy assessment of patients in their usual environment because the instrument is portable and does not require a radiology suite (10). Additionally, although VE is most useful for the examination of the integrity of the upper airway before and after a swallow response, it enables the evaluation of the tongue function during mastication and deglutition, as well as the detection of aspiration by the objective visualization of the airway (11, 12).

Videoendoscopic examination has been shown to successfully estimate the existence of accumulated oropharyngeal secretions, thus resulting in excellent prediction of aspiration (13, 14). In addition, Ota *et al.* (15) reported that the secretion scale based on the VE examination is a useful evaluation tool for predicting not only aspiration, but also pneumonia, in acute-phase dysphagic stroke patients. Furthermore, Link *et al.* (16) reported that there was a relationship between the VE-based pooled hypopharyngeal secretions, laryngeal penetration, aspiration and recurrent pneumonia with neurological disorders in pediatric patients. It is therefore evident that VE is the best tool to examine pooled hypopharyngeal secretions, laryngeal penetration, and aspiration. Therefore, even though the agreement rate between the VF and VE findings on dysphagia was shown to be high (90%) (17), VE examinations are becoming increasingly popular for examining the aspiration of saliva and food at the bedside and in long-term care facilities (17, 18).

In a prospective study with acute stroke patients, Lim *et al.* (19) found a strong association between aspiration detected by VE and the development of aspiration pneumonia. However, the predictors of aspiration pneumonia in dependent elderly patients with dysphagia in long-term care facilities have not been sufficiently investigated using VE. Therefore, the purpose of this prospective cohort study was to investigate whether the dysphagic signs identified by VE were risk factors for pneumonia and body weight loss in patients living in long-term care facilities.

Materials and methods

Subjects

Six hundred and forty-seven inpatients were initially identified from six nursing care facilities in Tokyo, Japan from March 2007 to February 2009 (Fig. 1). All patients, except for 28 subjects who were tube-fed, were screened for dysphagia by a check-list given to the patient's caregiver. The screening check-list contained 11 items: pooling of food, uncomfortable feeling in the throat, previous history of asphyxiation, previous history of aspiration, previous history of pneumonia, increased phlegm production, choking on saliva, choking on food, choking after a meal, prolongation of their eating time, and insufficient intake. The 171 patients who had at least one item checked positively by the caregiver were suspected to have dysphagia and comprised the intended sample population. However, 23 patients were excluded because of cognitive failure or refusal to participate in this study. Consequently, the final study population consisted of 148 patients (male/female: 43/105) with a mean age of 85·1 ± 8·0 years and an age range from 59 to 100 years. The protocol for this study was approved by the Ethics Committee of the Nippon Dental University School of Life Dentistry at Tokyo (#08-10).

Baseline measurements and feeding therapy

At the baseline measurement, a medical doctor assessed the patients' general health condition, and none of the patients fulfilled the Mann's criteria (7) for a diagnosis of pneumonia, that is, the presence of at least three of the following signs and symptoms: fever >38 °C, productive cough with sputum, tachypnea higher than 22 breaths per minute, inspiratory crackles,

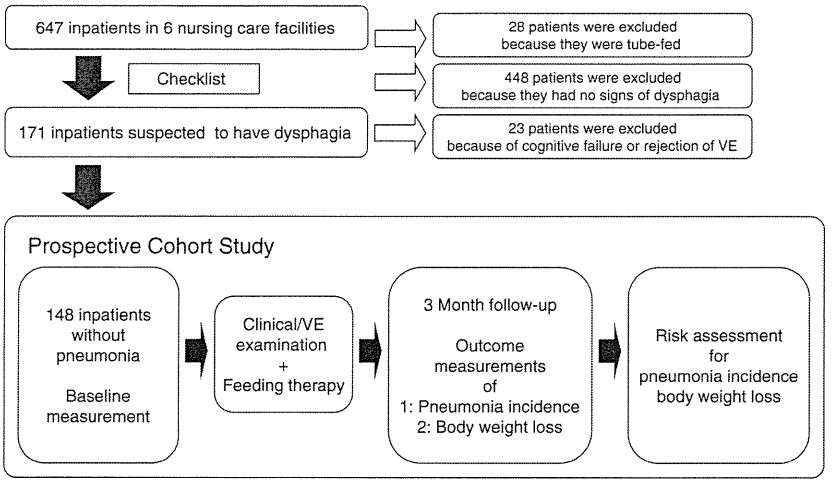

Fig. 1. The sampling process used for this study.

an abnormal chest x-ray, or positive gram staining and cultures.

All included subjects had their eating ability and dysphagic signs and symptoms evaluated clinically according to a clinical examination form regarding the signs and symptoms of dysphagia (spilling food, pooling food, oral food residue after a swallow, inability to open the mouth, choking/coughing, increased phlegm while eating, dyspnea, wet hoarseness, other), the hand and mouth coordination during the meal (feeding posture, prolongation of eating time) and the caregiver's technique used for feeding assistance.

In addition, each patient's swallowing function was examined by VE, which consisted of a flexible endoscope (ENF-V2*) connected to a high-intensity compact light source (CLH-SC*) and a video recorder (OTV-SC*).The endoscope was passed transnasally to the hypopharynx at a vantage point that provided a full view of the laryngeal vestibule, and was kept in place for a period of 10–15 min to assess the patient's eating ability, or saliva swallows when the patient was not consuming a meal. The patients were examined in their usual eating position, that is, the ambulatory patients were seating in the upright position, while the bed-bound patients were sitting on a bed. All swallows were recorded on videotapes for the further analyses by experienced physicians familiar with endoscopic swallowing studies and who were blinded to the intentions of the study. Each patient's video-recording data were reviewed for the presence or absence of pharyngeal residue, and penetration and aspiration of food or saliva. 'Penetration' was defined as a passage of material into the larynx that does not pass below the vocal folds, while 'aspiration' was defined as passage of material below the level of the vocal folds. In cases where the aspiration of food or saliva did not induce a cough, it was defined as 'silent aspiration' according to the criteria proposed by Rosenbek *et al.* (1996) (20). To assess the inter-rater reliability of the swallowing evaluations, the three investigators who were unaware of the original evaluation results, separately reviewed a random 10% sample of these evaluations. The overall agreement rate between investigators was substantial according to the Landis and Koch criteria (21) (kappa coefficient = 0·660).

On the basis of these aforementioned evaluations, the patients received various feeding therapies (22) during the follow-up period, for example, confirmation of feeding conditions [76 patients (51·4%) of 148 patients, multiple answers possible], appropriate feeding assistance [69 patients (46·6%)], food modification [32 patients (21·6%)], modification in feeding posture [19 patients (12·8%)] and modification in food intake [four patients (2·0%)] for 3 months. Food modification involved changing the dietary consistency. We modified the food and liquid texture individually according to the National Dysphagia Diet recommendations (23). Food intake and feeding assistance required modifications to accommodate the individual needs of the patients, such as changes in the rate and amount of the food consumed, appropriate utensils and the

*Olympus Corporation, Tokyo, Japan.

method used for self-feeding (22). Modifications in the feeding posture were applied in order to maximize the physical capabilities and improve swallowing, and involved strategies such as head-turn or chin-tuck maneuvers or whole body-positioning strategies including the patient tilting to the side or back, side-lying, or maintaining an upright posture (22). All patients received oral health care after every meal by the caregiver who was instructed once a week about the oral care procedures by a dental hygienist. Caregivers cleaned each patient's oral cavity using a toothbrush for approximately 5 min after each meal. The brushing was carried out as usual for daily tooth brushing without paste, and included brushing the palatal and mandibular mucosa and tongue dorsum. Dentures were also cleaned with a denture brush every day.

The 3 month follow-up and outcome measurement

The first outcome variable after 3 months of follow-up was the incidence of pneumonia diagnosed according to the same criteria applied at the baseline measurement. Once the patients received a diagnosis of pneumonia, they were sent to a local hospital for treatment, without exception. Consequently, their oral feeding was prohibited to prevent further aspiration pneumonia and their body weight typically decreased as a result (24). The incidence of pneumonia and body weight loss were therefore strongly correlated after the development of pneumonia. Thus, when pneumonia was identified, follow-up measurements of the patient's body weight were terminated.

The second outcome variable during the follow-up period was a change in body weight demonstrated by monthly measurements. Since there is a close relationship between pneumonia and body weight loss, the incidence of body weight loss of 3% or more was examined in patients who had not been diagnosed with pneumonia during the 3 months of follow-up. Once the patients developed a body weight loss of 3% or more, the patients received some form of nutrition therapy, and thus, the follow-up observation was terminated.

Statistical analysis

A survival curve of the patients who had not been diagnosed with pneumonia was drawn for a Kaplan–Meier analysis. According to the presence/absence of pneumonia during the 3 months of follow-up, we divided the final sample population into pneumonia and non-pneumonia sub-groups, and performed a *t*-test, chi-square analysis or Fisher's exact test to analyse the differences between the two groups.

Similarly, a survival curve of those patients who had not lost more than 3% of their body weight was drawn for a Kaplan–Meier analysis (outcome event: the incidence of body weight loss of 3% or more). Differences between the weight gain/no change sub-group (body weight gain, or a small weight loss of no more than 3% of the initial body weight) and the weight loss group (body weight loss of 3% or more (10, 25)) were analysed with the same statistical tests utilized for the incidence of pneumonia.

Additionally, a Cox proportional hazard analysis was performed to identify the risk factors for the incidence of pneumonia and the body weight loss of 3% or more. The analysed predictors were age, self-feeding ability, the Barthel activities of daily living (ADL) index, a body mass index (BMI) lower than 18·5, pharyngeal residue, laryngeal penetration, aspiration of food and aspiration of saliva. Regarding the aspiration of food or saliva, the data were handled as ordinal variables (negative, positive, positive as silent aspiration). The data were analyzed with the Statistical Package for the Social Sciences software program (SPSS version 15.0[†]). A *P*-value <0·05 was considered to be statistically significant.

Results

Baseline condition of the patients

Examination of the medical conditions of the initial 148 patients showed the presence of a prior stroke in 83 (comorbidity admitted) (56·1%), dementia in 74 (50·0%), Parkinson's disease in 10 (6·8%), cardiovascular disease in 10 (6·8%), hypertension in 8 (5·4%), previous pneumonia in 5 (3·4%), diabetes mellitus in 3 (2·0%), fractures in 3 (2·0%) and other comorbidities in 14 patients (9·5%).

The clinical examination regarding the eating ability and signs and symptoms of dysphagia before the VE evaluation showed choking/coughing in 110 out of 148 patients (multiple choice admitted), pooling of food in 28, prolongation of the eating time in nine, inability to

[†]SPSS Japan Inc., Tokyo, Japan.

open the mouth in two, and spilling of food in one patient.

The VE evaluation detected pharyngeal residue in 97 (65·5%) out of the 148 patients, laryngeal penetration in 67 (45·3%), aspiration of food in 41 (27·7%), silent aspiration of food in 19 (12·8%), aspiration of saliva in 8 (5·41%), and silent aspiration of saliva in 10 (6·76%) patients (Table 1).

Risk factors for pneumonia and body weight loss

Even with elaborative feeding therapy, during the 3 months of follow-up after the baseline measurement, 12 (8·1%) of the 148 patients developed pneumonia (Fig. 2). In addition, among the non-pneumonia patients, 90 (66·2%) of them presented with weight gain, no change or weight loss of 3% or less (weight gain/no change group), while 46 patients (33·8%) lost 3% or more of their body weight (weight loss group) (Fig. 3).

The differences between the pneumonia and non-pneumonia groups concerning the clinical/demographic data and the dysphagic signs detected by VE are shown in Table 1. The unpaired *t*-test showed that there were no significant differences in the patient age ($P = 0·505$), gender ($P = 0·244$), self-feeding ability ($P = 0·419$), number of patients with a BMI lower than 18·5 ($P = 0·190$), and the Barthel Index ($P = 0·060$) between the subjects with and without pneumonia. On the other hand, there was a significant difference in the frequency of 'aspiration of saliva' between the pneumonia and non-pneumonia patients ($P = 0·026$). In contrast, a comparison between the body weight gain/no change and body weight loss groups showed that there were no significant differences concerning any of the analysed variables (Table 2).

The results of the Cox proportional hazard analysis revealed that a sign of the 'aspiration of saliva' detected by VE was a significant risk factor for pneumonia (Table 3) and for a body weight loss of 3% or more (Table 4).

Discussions

The presence of aspiration-related pneumonia is known to be associated with a high mortality rate in the elderly. Patients in nursing homes may have a higher incidence of pneumonia because of their multiple underlying diseases, which may lead to immunosuppression, excessive use of medications, generalized decreased functional status, as well as factors related to malfunctioning of the masticatory and orophraryngeal systems and inadequate oral care. In particular, dysphagia is known to be strongly associated with aspiration pneumonia. Teramoto *et al.* (26). reported

Table 1. The relationship between the clinical/VE signs and the incidence of pneumonia

	Total subjects	No pneumonia ($n = 136$)	Pneumonia ($n = 12$)	*P*-value
Age (mean ± s.d.)	148	85·0 ± 8·1	86·8 ± 5·4	0·505†
Male/female	148	38/98	5/7	0·244††
Self-feeding (yes/no)	148	47/89	5/7	0·419††
Barthel Index (mean ± s.d.)	116*	13·1 ± 18·1	7·2 ± 7·12	0·060†
BMI < 18·5**	118**	43/110 (39·1%)	5/8 (62·5%)	0·190††
Pharyngeal residue	148	88 (64·7%)	9 (75·0%)	0·354††
Laryngeal penetration	148	62 (45·6%)	5 (41·7%)	0·519††
Aspiration of food	148			0·326††
Silent aspiration	19	19	0	
Aspiration	41	38	3	
NA	88	79	9	
Aspiration of saliva	148			0·026††
Silent aspiration	10	7	3	
Aspiration	8	7	1	
NA	130	122	8	

*Of 116 patients, 107 were in the no pneumonia group and nine were in the pneumonia group.

**Of 118 patients, 110 were in the no pneumonia group and eight were in the pneumonia group.

†*T*-test.

††Chi-square test.

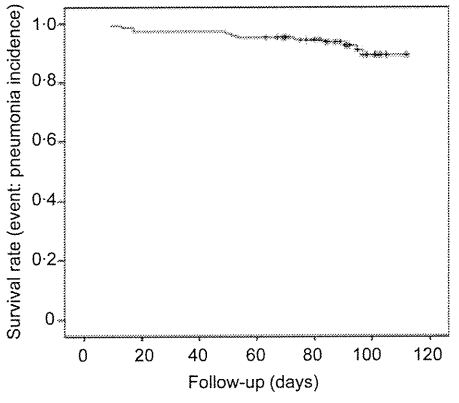

Fig. 2. The survival curve of the patients who did not suffer from pneumonia. The survival curve was drawn for a Kaplan–Meier analysis (outcome event: incidence of pneumonia).

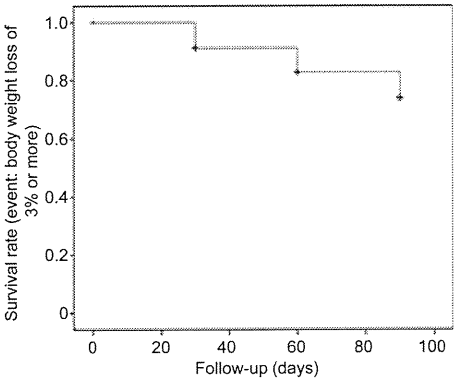

Fig. 3. The survival curve of the patients who did not suffer from a body weight loss of 3% or more. The survival curve was drawn for a Kaplan–Meier analysis (outcome event: incidence of body weight loss of 3% or more).

that 70% of the pneumonia in the elderly occurred due to aspiration, and Yamaya *et al.* (27). reported a high prevalence of silent aspiration in older persons leading to the deterioration of swallowing function due to cerebrovascular disease. In a previous study, Doggett *et al.* (28) estimated that approximately 43–54% of stroke patients have dysphagia and aspiration of food or saliva, and that approximately 37% of these patients would develop aspiration-related pneumonia.

In this present study, penetration and aspiration (apparent or silent) was observed in 67 subjects (45·2%) and 60 subjects (40·5%), respectively. The prevalence of aspiration found in this investigation was relatively high compared to previous studies utilizing VE examination (29%) (29), but was similar to the range observed in a previous review article where it was reported to occur in 15–39% of subacute dysphagic stroke patients (30). According to this review, the exact prevalence of aspiration remains unknown because of the differences in the size and methodology used in the existing studies.

The incidence of pneumonia was 12 (8·1%) among the 148 subjects (Table 1), which is in accordance with the study by Lim *et al.* (19), who reported that five patients (10%) developed pneumonia during their inpatient stay, and that all of them were at risk of aspiration of saliva or food as determined by a VE examination. On the other hand, Croghan *et al.* (6) reported that 55% of their nursing home patients presented with aspiration on VF examination, and 43% developed pneumonia.

One possible reason for such a discrepancy in the association of pneumonia and aspiration or penetration could be due to the technique (VE vs. VF) utilized to assess the swallowing disorders. Although a number of methods have been used to detect the symptoms of dysphagia, it is very difficult to evaluate 'silent aspiration of saliva' with a bedside clinical assessment alone, because it has been shown that it is missed in up to 40% of the patients aspirating silently (31, 32). At present, VF and VE are regarded as the best methods to evaluate swallowing function. In particular, VF has been used as a gold standard to evaluate swallowing because it can detect aspiration. However, it may not be as accurate in identifying 'silent aspiration of saliva', as compared to VE, because the latter enables direct visualization of the aspiration of saliva (18, 33, 34). Kelly *et al.* (35) reported that penetration and aspiration are perceived more sensitively in VE images than in VF images of the same swallows. It is also well known that VE can identify the microaspiration and aspiration of secretions with a high reliability, whereas VF cannot (36, 37). Additional advantages of VE are related to its application. Inpatients may become agitated or fatigued in the radiology suite or may not respond well to the taste of barium-coated boluses, or may even reject the radiation exposure, limiting the applications of VF. Videoendoscopy allows the patient's examination to be performed regardless of his/her altered mental status or immobility (38). Finally, Wu *et al.* (39) stated that VE is conclusively a safe, more efficient and sensitive method than VF for evaluating swallowing.

Another reason for the discrepancy could be the effect of the feeding therapy provided in this study, which could have reduced the symptoms of dysphagia,

Table 2. The relationship between the clinical/VE signs and the change in body weight

	Total subjects	Gain/no change (n = 90)	Weight loss (n = 46)	P-value
Age (mean ± s.d.)	136	84·6 ± 8·0	85·7 ± 8·6	0·464†
Male/female	136	25/65	13/33	0·553††
Self-feeding (yes/no)	136	29/61	16/30	0·454††
Barthel Index (mean ± s.d.)	107*	14·9 ± 18·7	9·6 ± 17·0	0·163†
BMI < 18·5	110**	30/74 (40·5%)	13/36 (36·1%)	0·655††
Pharyngeal residue	136	61 (67·8%)	27 (58·7%)	0·294††
Laryngeal penetration	136	44 (48·9%)	18 (39·1%)	0·2797††
Aspiration of food	136			0·975††
Silent aspiration	19	13	6	
Aspiration	38	25	13	
No aspiration	79	52	27	
Aspiration of saliva	136			0·342††
Silent aspiration	7	4	3	
Aspiration	7	3	4	
No aspiration	122	83	39	

Weight loss was diagnosed as the loss of 3% or more of the body weight from the baseline measurement.
*Of the 107 patients, 72 were in the gain/no change group and 35 were in the weight loss group.
**Of the 110 patients, 74 were in the gain/no change group and 36 were in the weight loss group.
†T-test.
††Chi-square test.

Table 3. The results of the Cox proportional hazard analysis for the possible predictors of the incidence of pneumonia

Predictors	B	P-value	HR	95% CI
Age	0·011	0·860	1·011	0·900–1·135
Self-feeding	0·105	0·909	1·111	0·182–6·785
Barthel Index	−0·010	0·769	0·990	0·927–1·057
BMI < 18·5	2·064	0·070	7·874	0·844–73·440
Pharyngeal residue	−0·621	0·615	0·537	0·048–6·067
Laryngeal penetration	0·571	0·642	1·771	0·160–19·644
Aspiration of food (negative/positive/ positive with SA)	−0·216	0·830	0·805	0·112–5·794
Aspiration of saliva (negative/positive/ positive with SA)	1·290	0·025	3·634	1·174–11·242

HR, hazard ratio; CI, confidence interval; SA, silent aspiration.

Table 4. The results of the Cox proportional hazard analysis for the possible predictors of a body weight loss of 3% or more

Predictors	B	P-value	HR	95% CI
Age	0·019	0·448	1·019	0·971–1·070
Self-feeding	0·530	0·228	1·698	0·718–4·014
Barthel Index	0·000	0·992	1·000	0·976–1·025
BMI < 18·5	0·859	0·032	2·362	1·074–5·191
Pharyngeal residue	−0·060	0·896	0·942	0·381–2·325
Laryngeal penetration	0·019	0·970	1·019	0·374–2·780
Aspiration of food (negative/positive/ positive with SA)	−0·203	0·569	0·816	0·405–1·644
Aspiration of saliva (negative/positive/ positive with SA)	1·186	0·000	3·275	1·828–5·866

HR, hazard ratio; CI, confidence interval; SA, silent aspiration.

pharyngeal residue, laryngeal penetration, and aspiration of food, as demonstrated by the fact that 66% of the subjects were able to increase their body weight or keep the body weight loss to within 3%. Nevertheless, a detailed analysis of the effectiveness of feeding therapy on the reduction of the symptoms of dysphagia could not be performed, because it was beyond the scope of this study.

Additionally, the differences in the target populations and their respective medical conditions could also have affected the overall incidence of pneumonia. This study gathered a heterogeneous patient population consisting of patients presenting with well-known disorders/diseases associated with the symptoms of dysphagia (e.g. stroke, Parkinson's disease, dementia) as well as other non-debilitating diseases/disorders (hypertension, fractures). On the other hand, a strong point in this study was the inclusion of a relatively high number of subjects from six nursing care facilities, which was large compared to other follow-up studies. Therefore,

the incidence of pneumonia may have been relatively lower in such a large heterogeneous study sample.

Regarding the risk factors associated with the development of pneumonia, some of them were reported to be age, primary disease, consciousness disorders, nutritional status, poor ADL, poor oral status, and swallowing dysfunction (40, 41). In the present study, among the analysed predictors, the 'aspiration of saliva' detected by VE was the only significant risk factor for pneumonia. In cases of bad oral health, saliva contains numerous bacteria. Therefore, patients with silent aspiration of saliva (without a cough reflex) are aspirating bacteria, which may be the main factor responsible for increasing the risk of pneumonia.

Additionally, even with the elaborative feeding therapy provided in this study, the control of aspiration of saliva or silent aspiration of saliva was generally difficult. In the present study, there was also a tendency for there to be a higher incidence of pneumonia in poor ADL patients. Langmore *et al.* (42) also reported that severely dependent functional status was an especially potent predictor of aspiration pneumonia. Riquelme *et al.* (40) reported that there was a significant relationship between the ADL and mortality rate. It was also observed that patients with a BMI < 18·5 had a higher tendency to develop pneumonia ($P = 0{\cdot}070$) compared with those with a poor ADL ($P = 0{\cdot}769$). It is well known that a lower nutrition condition affects the host immunological function, thus making the subjects more susceptible to pneumonia (43).

On the other hand, aspiration of saliva was also detected as a significant risk factor for body weight loss in this study. This finding could be explained by the possible presence of subclinical aspiration-related pneumonia in those subjects with a body weight loss of 3% or more.

The overall findings in this study demonstrated that it is still very difficult to prevent aspiration of saliva even if physicians provide elaborative feeding therapy and even if patients do not eat and drink anything through the mouth. Effective strategies to prevent the silent aspiration of saliva will therefore be an important target for future research.

Conclusion

The results of this study showed that, even with elaborative feeding therapy, 'aspiration of saliva' as detected by videoendoscopic examination was found to be a significant risk factor for pneumonia and a body weight loss of 3% or more in elderly patients living in nursing homes.

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ORIGINAL ARTICLE: EPIDEMIOLOGY, CLINICAL PRACTICE AND HEALTH

Correlation between dental and nutritional status in community-dwelling elderly Japanese

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Aim: The purpose of this study was to clarify the correlation between dental and nutritional status among community-dwelling elderly Japanese people.

Methods: The subjects were 182 elderly individuals, aged 65–85 years, who voluntarily participated in a health seminar at Kyoto Prefectural University of Medicine. These subjects were divided into two groups according to the occlusion. The subjects in the retained contact group were those who had retained molar occlusion with natural teeth. The lost contact group were those who retained molar occlusion with removable partial dentures. Anthropometric variables such as body mass index (BMI) were collected and dietary intake was assessed using a brief self-administered diet history questionnaire (BDHQ).

Results: No statistical difference in BMI or intake of macronutrients was found between these two occlusal groups. The lost contact group reported significantly lower consumption of vegetables and higher consumption of confectionaries (foods rich in sugar) than did the retained contact group ($P < 0.05$), and therefore had significantly lower intake of vitamin C and dietary fiber ($P < 0.05$).

Conclusion: It can be concluded that natural tooth contact loss in the posterior region affect the intake of vitamins and dietary fiber. **Geriatr Gerontol Int 2011; 11: 315–319.**

Keywords: elderly, nutrition, occlusion, tooth loss, Japanese.

Introduction

The intake of nutrients as a result of food consumption is fundamental to maintaining life.[1] Many reports have shown that low food volume and an unbalanced diet are related to tooth loss, poor occlusion and other oral pathological conditions.[2–5] In particular, individuals with fewer teeth tend to avoid raw fruits and vegetables, thus reducing their intake of vitamins and dietary fiber.[6,7] Adequate intake of these nutritional elements is thought to prevent cardiovascular disease, cancer and other systemic conditions.[8,9]

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Author contribution: Mitsuyoshi Yoshida conceptualized and designed study, analyzed and interpreted data, wrote and edited the manuscript; T. K. collected data about nutritional status; M. Y. and K. T. collected data about dental examination; M. K. collected data about physical examination; and Y. A. supervised study concept and design.

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Many previous studies on this topic have been conducted in Western countries and concluded that tooth loss affects elements of nutritional intake such as dietary fiber and vitamins. However, only a few studies have been conducted previously in Japan[10–12] and may not reach a consensus. Yoshihira *et al.*[10] found no significant difference between the number of teeth present and the intake of vitamin C or dietary fiber among 57 healthy 74-year-old elderly Japanese people. However, the subjects in their study were divided into two groups only with teeth numbers as more than 20 teeth or less. We hypothesize that natural tooth contacts in the molar region are more important to the consumption of foods requiring more mastication and, as a result, this study was conducted to clarify the correlation between natural tooth contact loss and nutritional intake of vitamins and dietary fibers among community-dwelling elderly Japanese people.

Methods

The subjects were 182 healthy elderly Japanese (60 men, 122 women) aged 65–85 years living in Kyoto and participating in a health seminar sponsored by Kyoto Prefectural University of Medicine. According to brief medical interview, anyone who had a history of cardiovascular disease was excluded from the study because they had some risk completing physical assessment (original purpose in this seminar). This study was approved by the Ethics Committee at Kyoto Prefectural University of Medicine. All subjects gave verbal informed consent.

Based on oral examination, the subjects were divided into two groups according to the Eichner Classification.[13] This classification was based on existing natural tooth contacts between maxilla and mandible in the bilateral premolar and molar regions (presence of tooth contact defined as presence of a natural tooth on the maxilla and corresponding mandible, including wisdom teeth, but excluding remaining roots or root caps). Class A represents contact in all four support zones. Class B represents contact in three to one zone (B1–B3) or in the frontal region only (B4). Class C represents absence of tooth contact. The retained contact group consisted of those classified as Eichner A or B1–B3, who had retained molar occlusion in at least one molar region with natural teeth. The lost contact group consisted of individuals classed as Eichner B4 or C who had no occlusal contact with natural dentition in the molar region. All subjects in the lost contact group used removable partial dentures.

Anthropometric measurements were as follows. Body mass index (BMI, kg/m^2) is defined as the weight in kilograms divided by height in meters squared. Mid-upper arm circumference (AC, cm) was measured on the left arm with a tape measure. Triceps skinfold (TSF, cm) was measured with Harpenden calipers over the triceps muscle at the midway point between the acromion and the olecranon process. Three repeat measurements were taken to the nearest 0.5 mm, with the mean taken as the true value.

Food intake was assessed with a brief self-administered diet history questionnaire (BDHQ) along with interviews by a dietitian. The BDHQ had been developed by item-reduction from a validated self-administered diet history questionnaire (DHQ) used earlier.[14] The BDHQ is a 4-page structured questionnaire with 75 questions (55 relating to food consumption and 17 to cooking and dietary behaviors). The questionnaire assessed dietary habits during the preceding month. From this information, energy, nutrient and food intakes were calculated using an ad hoc computer algorithm for BDHQ. The validity of this questionnaire was established elsewhere that average Pearson correlation coefficients for 37 nutrients between nutrient intakes assessed with BDHQ and 16-day dietary record in adults was 0.48 in 92 men and 0.49 in 92 women.[15]

Using information from the questionnaires, nutrient intake and the intake of protein, fat and carbohydrate were calculated and evaluated in terms of the macronutrient intakes of the two groups (Table 3) based on the Standard Tables of Food Composition in Japan (5th ed.).[16] The intake of vitamins and dietary fiber were per 1000 kcal were also calculated. Multivariate ANOVA was used to compare the two occlusal groups with sex and age as covariates. Age was categorized into four groups: 65–70, 71–75, 76–80 and 81–85 years. SPSS ver. 15 was used for these analyses and all statistical significance levels set at $P < 0.05$.

Results

The retained contact group included 138 subjects (41 men, 97 women, average age 74.4 ± 3.6 years) and the lost contact group included 44 subjects (19 men, 25 women, average age 77.0 ± 5.3 years). The distributions in terms of sex did not differ, but the members of the lost contact group were significantly older than the retained contact group ($P = 0.004$). The comparisons of body composition between the two groups are shown in Table 1. Measures of AC and TSF were significantly lower in the lost contact group.

According to the data calculated from the BDHQ questionnaires, the lost contact group consumed significantly fewer vegetables and more confectionaries than the retained contact group (Table 2). Energy intake was not significantly different between the retained contact group and the lost contact group (1934 ± 59 vs 2057 ± 76 kcal/day, respectively, $P = 0.132$). There was no statistical difference between the two occlusal groups in macronutrients. Protein and carbohydrate were in the range of the Standard Tables of Food Composition in