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Association between serum albumin and periodontal disease in community-dwelling elderly

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Abstract

Aim: The purpose of this study was to evaluate the relationship between periodontal disease and general health status in community-dwelling elderly using serum albumin concentration as a criterion index of the severity of an underlying disease and nutrition status.

Methods: Serum albumin level was detected by the bromcresol green albumin (BCG) method and the data for serum albumin were available in 368 subjects aged 75 years. Pressure-sensitive probes were used to measure loss of attachment (LA) on six sites of all teeth present. Information relevant to gender and smoking habit was obtained by means of a personal interview, while body mass index (BMI) and biochemical serum markers were investigated.

Results: Serum albumin concentration ranged from 3.2 to 4.8 g/dl with a mean of 4.1 ± 0.2. More than 70% of subjects had at least one site with LA 6+ mm, while 91 exhibited 10% or more sites with LA 6+ mm. Using a multiple regression analysis, we found that sites of LA 6+ mm had a significant effect on serum albumin level (correlation coefficient $= -0.14$; $p < 0.05$), which was independent of the other covariates.

Conclusions: The findings of the present study indicated that there might be an inverse relationship between periodontal disease and serum albumin concentration in these elderly subjects.

Key words: elderly; epidemiology; nutrition; periodontal disease; serum albumin

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Periodontal infection has been implicated as a risk factor for systemic diseases such as coronary heart disease and diabetes (Genco et al. 2001, Taylor 2001, Nishimura et al. 2003). It has been suggested that impaired dentition status such as tooth loss owing to periodontal infection may affect individuals by causing dietary restrictions via difficulty in chewing, possibly compromising their nutritional status and well-being (Chauncey et al. 1984, Papas et al. 1989, Hollister & Weintraub 1993). However, the association between periodontal disease and general health, including nutritional status, in the elderly who may be at a higher risk of developing inflammatory conditions or disorders is still unclear.

Serum albumin levels might be a practical marker of the general health status as they describe the severity of an underlying disease and mortality in elderly (Phillips et al. 1989). According to Herrmann et al. (1992), many conditions, such as inflammatory states, liver diseases and renal diseases, have been indicated to reduce serum albumin levels. Moreover, malnutrition also may be monitored by means of the serum albumin concentration (Don & Kaysen 2004). Serum albumin levels remain virtually unchanged even in the presence of protein calorie malnutrition in otherwise healthy individuals until near terminal starvation. It may be suggested that lower albumin levels have a complex aetiology rather than reduced protein intake alone contributing to hypoalbuminaemia (Rigaud et al. 2000).

In terms of association between oral disease and serum albumin concentration, Yoshihara et al. (2003) have recently reported that the number of untreated teeth was a significant factor associated with serum albumin concentration in elderly. Therefore, it is apparent that oral disease burden might be indicated and monitored by the levels of serum albumin; however, few studies have been performed or reported to see the relationship between periodontal disease status and serum albumin concentration.

Consequently, we adopted the serum albumin concentration as a criterion, which indicates the general health

condition including nutrition status, and designed this study to investigate how periodontal disease condition may influence the serum albumin concentration in the elderly.

Materials and Methods

At the beginning, 4542 (2099 males and 2443 females) Niigata citizens aged 70 years were sent a written request to participate in the survey and were informed of the purpose of this survey. After two requests, 81.4% (3695) responded positively to participate in the survey. Considering the availability of resources, appointments for examinations could be arranged only for 600 persons. The final study sample was randomly recruited from several divisions in Niigata in order to have an approximately equal number of males (306) and females (294). All subjects agreed and signed informed consent forms regarding the protocol, which was reviewed and approved by the Ethics Committee of the Faculty of Dentistry, Niigata University. The subjects who participated in the survey in 1998 were recalled and re-examined in 2003. Among them, 368 (194 males and 174 females) subjects examined as dentate in 2003 and in whom the levels of serum albumin were evaluated were targeted for this cross-sectional study.

None of the subjects was hospitalized or institutionalized. They did not require special care for their daily activities, and had high scores of reliability and validity in a multidimensional 13-item index of competence (TMIG index of competence) (Koyano et al. 1991).

A personal interview was conducted to obtain the information regarding gender, smoking habit. Anthropometric evaluation included measurements of weight and height for the calculation of body mass index (BMI). In addition, biochemical values such as total protein, calcium, total cholesterol, c-reactive protein, high-density lipoprotein (HDL)-cholesterol, triglyceride and immunoglobulin G (IgG) were also evaluated, while the serum level of albumin was measured by the bromcresol green albumin (BCG) method. Four dentists carried out intra-oral examination under sufficient illumination using artificial light. The periodontal condition, measured as loss of attachment (LA), was recorded using mouth mirrors and specially designed pressure-sensitive Vivacare, TPS Probe® (Vivacare, Schaan, Liechtenstein). Probing was performed at six sites per tooth for all teeth present, and the measurements were recorded approximately to the nearest whole millimetre. The examiners were calibrated both before and during the survey, and κ values between each pair of examiners were in the range of 0.62–1.00 for assessing the attachment level.

Statistical analyses were performed as follows. Initially, serum albumin concentration was considered as a dependent continuous variable and the unit of analysis was the subject. Gender (male, female), smoking habit (yes, no), BMI (<20, $\geqslant 20$), the percentage of sites with LA 6+ mm ($<10\%$, $\geqslant 10\%$) and the number of teeth present (<20, $\geqslant 20$) were selected as independent variables. Student's *t*-test was employed to compare the difference between two means. In addition, the relationship between serum albumin concentration and percentage of sites of LA 6+ mm and serum values for nutritional and biochemical parameters were evaluated by Student's *t*-test. Finally, a multiple linear regression analysis was used to estimate the independent effect of periodontal disease status on serum albumin level while controlling for confounding factors. Serum albumin concentration was used as the dependent variable, while the variables that showed significant relationships with serum albumin concentration at $p \leq 0.05$ in initial analyses were selected as independent variables. All calculations and statistical analyses were performed using the STATA® software package.

Results

Out of the sample, 48.1% of subjects had smoking experience, while 12.8% of them were current smokers. The mean number of remaining teeth was 18.1 per subject. More than 70% of subjects had at least one site with LA 6+ mm, while 91 (24.7%) exhibited 10% or more of sites with LA 6+ mm as severe periodontal disease. The serum albumin level of the sample was 3.2 to 4.8 g/dl with a mean of 4.1 ± 0.2 (results not shown in the table).

Table 1 shows the relationship between individual characteristics, dental status and serum albumin concentration. Male subjects or smokers* showed a significantly lower level of serum albumin ($p<0.001$, $p=0.008$*), respectively. Subjects with 10% or more sites of LA 6+ mm also showed lower serum albumin concentration compared with subjects who have less than 10% of sites with LA 6+ mm ($p=0.003$). There were no significant differences between number of teeth present, BMI and serum albumin concentration. Relations between serum albumin and serum parameters for nutritional and biochemical values are listed in Table 2. Subjects with a lower level of total protein (<6.5 g/dl), calcium (<4.5 mEg/l), c-reactive protein (>0.45 mg/dl) and total cholesterol (<150 mg/dl) had significantly lower serum albumin concentrations ($p<0.001$). In addition, the subjects with a lower level of total cholesterol and a higher level of c-reactive protein* had a significantly greater percentage of sites with LA 6+ mm ($p<0.001$, $p<0.05$*), respectively. Table 3 shows the final multiple regression models for serum albumin alongside the independent variables that demonstrated significant effects on serum albumin. It was found that percentage of sites of LA 6+ mm had a significant effect on serum albumin (correlation coefficient $=-0.14$; $p<0.05$), which was independent of the other covariates.

Table 1. Relationship between serum albumin, subject characteristics and dental status

	Serum albumin (g/dl): mean (SD)	*p*-value
Gender		
Male	4.07 (0.23)	<0.001
Female	4.18 (0.22)	
Smoking habit		
Yes	4.08 (0.24)	0.008
No	4.15 (0.22)	
BMI		
<20	4.10 (0.27)	NS
$\geqslant 20$	4.12 (0.23)	
% of sites with LA 6+ mm		
$<10\%$	4.14 (0.23)	0.003
$\geqslant 10\%$	4.06 (0.22)	
No. of teeth present		
<20	4.11 (0.22)	NS
$\geqslant 20$	4.13 (0.24)	

NS: not significant.

Discussion

In this cross-sectional investigation, a significant association was found between periodontal disease as measured by percentage of sites with LA 6+ mm and the serum albumin concentration. In

Table 2. Relationship between serum albumin, periodontal disease and serum bloods parameters for nutritional and biochemical values

Parameters	Category	No. of subjects	Serum albumin (g/dl)			Sites with LA 6+ mm	
			mean	SD	*p*-value	%	*p*-value
Total protein (g/dl)	<6.5	17	3.78	0.24	<0.001	7.7	NS
	6.5–8.2	344	4.14	0.22		8.3	
	>8.2	5	4.04	0.19		13.5	
Calcium (mEg/l)	<4.5	88	3.95	0.23	<0.001	7.9	NS
	⩾4.5	278	4.17	0.21		8.5	
Total cholesterol (mg/dl)	<150	17	3.96	0.26	<0.001	21.4	<0.001
	150–219	250	4.09	0.23		8.6	
	⩾220	99	4.22	0.22		5.4	
C-reactive protein (mg/dl)	⩽0.45	354	4.13	0.23	<0.001	8.0	<0.05
	>0.45	12	3.87	0.24		16.4	
HDL-cholesterol (mg/dl)	<40	28	4.05	0.22	NS	9.5	NS
	⩾40	338	4.13	0.24		8.2	
Triglyceride (mg/dl)	<50	16	4.04	0.28	NS	12.4	NS
	50–149	231	4.11	0.24		8.6	
	⩾150	118	4.15	0.22		7.4	
IgG (g/dl)	<1000	39	4.16	0.25	NS	4.8	NS
	1000–1900	316	4.12	0.23		8.6	
	>1900	11	3.98	0.19		13.8	

NS: not significant.

Table 3. Multiple linear regression and associated *p*-values

Independent variables	Dependent variable serum albumin (g/dl)				
	coefficient	standarad error	*p*-value	95% CI	
% of sites with LA 6+ mm	−0.137	0.067	<0.05	−0.268	−0.048
Total protein(g/dl)	0.146	0.023	<0.001	0.100	0.192
Calcium (mEg/l)	0.490	0.057	<0.001	0.377	0.602
Total cholesterol (mg/dl)	0.001	0.000	0.001	0.001	0.002
C-reactive protein(mg/dl)	−0.117	0.029	<0.001	−0.174	−0.060
Gender	0.041	0.030	0.173	−0.018	0.101
Smoking habit	−0.050	0.029	0.087	−0.108	0.007
Constant	0.638	0.237	<0.05	0.172	1.103

$p<0.001$, $R^2 = 0.4503$.

fact, we observed an inverse independent relationship between periodontal disease and serum albumin concentration. Some epidemiological studies have demonstrated a relationship between dental status and level of serum albumin. According to Mojon et al. (1999), institutionalized older adults (mean age = 85 years) who had teeth with vertical mobility combined with periodontal pockets greater than 6+ mm had a significantly lower serum albumin concentration (3.3 g/dl). More recently, Yoshihara et al. (2003) reported that the number of untreated teeth was a significant factor associated with lower serum albumin concentration in an elderly population. Accordingly, our results have supported previous reports indicating an association between oral health status, in particular periodontal disease, and level of serum albumin.

Hypoalbuminaemia may be linked to various adverse effects. Several researchers have proposed an association between serum albumin level and mortality rate. Corti et al. (1994) investigated the relationship between serum albumin level and all-cause mortality in an elderly population aged 71+ years, and reported graded increase in mortality rate with decreasing albumin level while hypoalbuminaemia was associated with a significantly increased mortality rate. Phillips et al. (1989) also reported that there was a marked increase in mortality rate with decreasing serum albumin concentrations that persisted even after adjusting for age, social class, town of residence, cigarette smoking, serum total cholesterol, serum total calcium and systolic blood pressure. Moreover, according to Shibata et al. (1991), subjects aged 69–71 years who were divided into four groups by the quartile of serum albumin levels (− 4.1, 4.2–4.3, 4.4–4.5, 4.6+ g/dl) had significantly different 10-year survival rates. Even a difference in survival rates between the first and second quartiles was evident. Therefore, the present findings indicated that periodontal disease status denoted by the percentage of sites with LA 6+ mm might have a substantial influence not only on the subjects' serum albumin levels but also on general health aspects.

Although the precise mechanism underlying the serum albumin–periodontal relationship is not well understood, we hypothesize that this relationship might be explained by the following two conceivable possibilities, namely, the influence of nutritional aspect or chronic disease aspect (Yoshihara et al. 2003). According to our results, serum albumin concentration was significantly associated with lower levels of total protein, calcium, c-reactive protein and total cholesterol. In addition, our subjects with less than 150 mg/dl of total cholesterol and more than 0.45 mg/dl of c-reactive protein* showed significantly lower serum albumin levels and a higher percentage of sites with LA 6+ mm ($p<0.001$, $p<0.05$*), respectively. Therefore, our results suggested that not only the nutritional aspect but also the inflammatory reactants might be influenced by both serum albumin concentration and periodontal disease condition. Indeed, several reports have indicated a relation between nutritional condition and serum albumin (Magagnotti et al. 2000, Giordano et al. 2001), though a few studies have observed an association between nutritional aspects (mainly vitamin C) and periodontal disease (Ismail et al. 1983, Nishida et al. 2000, Amarasena et al. 2005).

A significant association between serum albumin concentration and IgG has also been reported (Goubran Botros et al., 1996). C-reactive protein is not a nutritional parameter but may be used to identify the presence of inflammation in individuals with a lower serum albumin concentration (Gabay & Kushner 1999). The level of serum albumin may fall owing to a variety of infections with an increase of c-reactive protein and IgG, concentration. Elevated c-reactive protein

and IgG levels in periodontal patients have been reported (Noack et al. 2001, Sahingur & Cohen 2004). The present study, however, failed to show a statistically significant correlation between serum albumin and IgG though c-reactive protein had such an association. The serum albumin concentration showed a tendency to decrease with increasing levels of IgG. A statistically significant association was not found between IgG and periodontal disease conditions.

Considering these results, it could be suggested that the significant relationship between periodontal disease and serum albumin concentration in our subjects might be influenced by nutritional aspects rather than chronic infectious disease. On the other hand, Mojon et al. (1999) reported that a compromised oral functional status has little influence on the nutritional status of semi-dependent elders, while those in poorer health might be more susceptible to poor oral function. In addition, the rate of albumin synthesis in elderly subjects might not be sensitive to changes in protein intake (Walrand et al. 2000). It has also been reported that synthesis speed of albumin in the liver in the elderly is not influenced by the ingestion of protein.

As there is no uniformity in case definitions or the method used among studies, the effect of periodontal disease on the level of serum albumin that has been shown by these studies is strictly not comparable. Moreover, this study population may be considered a biased one as it consisted of generally dynamic, independent and non-institutionalized elderly people who volunteered to participate in the survey (Amarasena et al. 2005). It has been observed that such non-institutionalized elderly who are active and independent may be less prone to severe periodontal disease than institutionalized elderly who are less active and dependent (Hirotomi et al. 2002, Ogawa et al. 2002).

In view of these facts, and because of the cross-sectional design of the present study, we cannot confirm a clear cause–effect relationship between serum albumin and periodontal disease at this stage. In order to explore the actual relationship between periodontal disease status and serum albumin level, further prospective studies and clinical trials will be necessary.

In conclusion, the findings of the present study might point to a statistically significant association between periodontal disease status and serum albumin concentration in this elderly population.

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Clinical Relevance

Scientific rationale: Oral health may be integral to general health and essential for the well-being of the elderly.

Principal findings: Periodontal disease condition might be linked with reduced levels of serum albumin, which in turn could be caused by nutritional status in the elderly.

Practical implications: Appropriate care and cure for periodontal disease may contribute to maintain good general health and it could be monitored through the level of serum albumin.