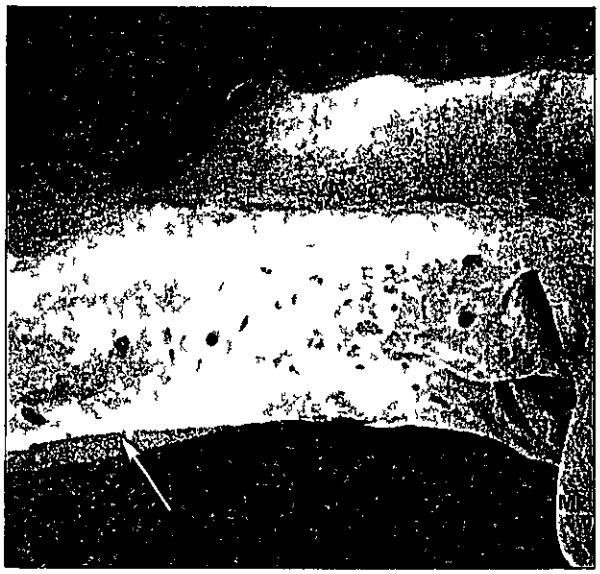
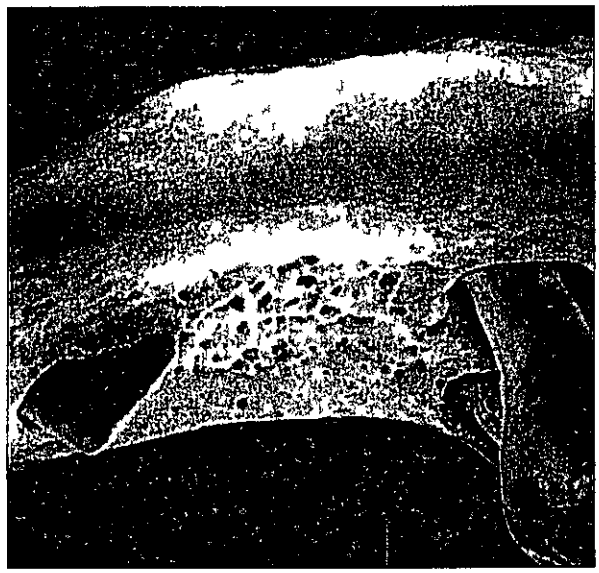
***Figs 1a to 1c*** *SEM images of implant sites Im = implant M2 = maxillary second molar tooth (original magnification ×20)*





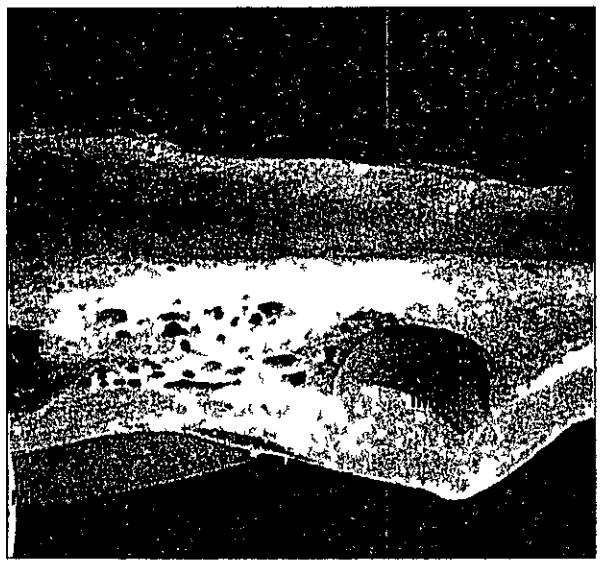


**Fig 1a** *(Above)* Implant with rhBMP 2 (group 1) Arrow indicates the periosteal surface of the rhBMP 2–induced bone which kept the implant submerged

**Fig 1b** *(Above right)* Implant with the carrier only (group 2) the coronal part is exposed and bone regeneration is different between the 2 sides

**Fig 1c** *(Right)* Implant with no treatment (group 3) the entire coronal part is exposed (maxilla opposite of Figs 1a and 1b)

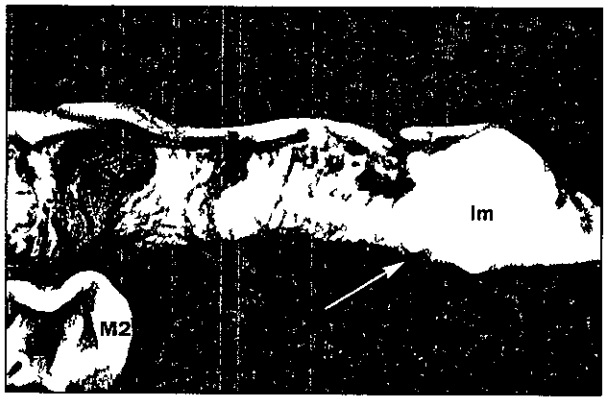
horizontal straight line along the upper border of the maxillary bone (base of the maxillary sinus) on the photomicrographs taken at the same magnification One vertical line touched the most mesial point of the implants while the other 2 lines passed through or ended at the coronal edges of the implants Apical distance between the horizontal line and the apical end of the implants in all groups and the heights of the newly formed coronal bone that covered the implants in group 1 were measured on these vertical lines Data on respective items for group 1 were compared with those of group 2 and group 3 separately by paired Student *t* tests and *P* values $< 05$ were considered significant

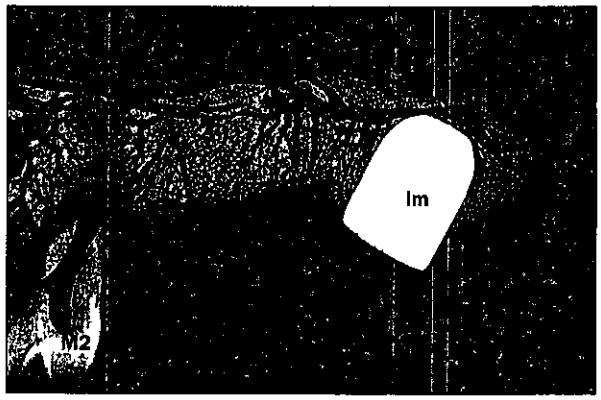
## RESULTS

On clinical examination gingival healing over the implants was uneventful only 1 implant from group 3 was lost during the period of integration No infection or soft tissue dehiscence was observed during the 90 days of the postsurgical period

SEM of the implant sites displayed the fine textured structural conditions of bone around the coronal part of the implants (Figs 1a to 1c) In group 1 it was very difficult to locate the implants because new bone almost entirely covered the coronal part of the implants (Fig 1a) The surface of the new bone was smooth with small osteocyte lacunae featuring a surface structure similar to that of the adjoining alveolar bone (Fig 1a) In group 2

*Figs 2a to 2c* *CMR images of sections sagittally cut from the mesiodistal direction Im = implant M2 = maxillary second molar tooth (original magnification ×20)*



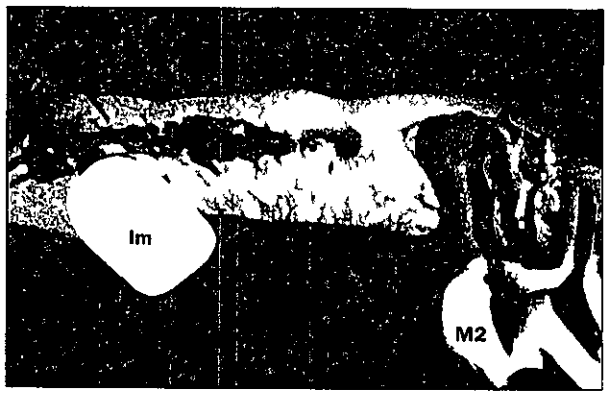




**Fig 2a** *(Above left)* Group 1 implant which remained submerged at the same level as the adjoining alveolar bone the arrowhead points to the bone that covers the implant

**Fig 2b** *(Above)* Group 2 implant which was exfoliated beyond the height of the alveolar bone

**Fig 2c** *(Left)* Group 3 implant Nearly half of each implant was exfoliated out of the alveolar bone (maxilla opposite of Figs 2a and 2b)

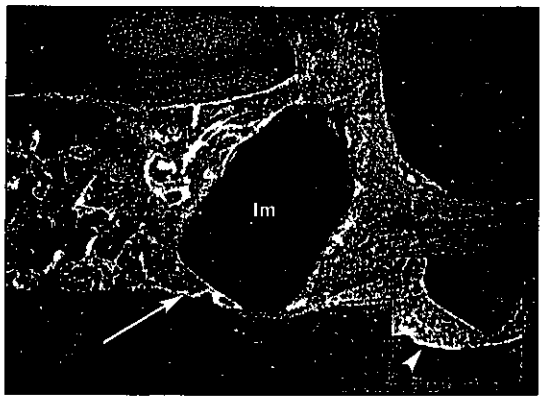
approximately 0 5 mm (average 0 3 mm) of the implant remained exposed on the mesial wall and the alveolar crest was not firmly attached to the implant (Fig 1b) In group 3, 0 3 to 0 5 mm of the entire coronal part of the implant remained exposed and the alveolar crest formed only a craterlike profile with the implant (Fig 1c)

CMR showed bone around the implants in group 1, with a wide range of bone to implant contact here the implants apparently remained stable in the original sockets and as a result the implants were the same height as the adjoining alveolar bone The bone covering the top also was evident (Fig 2a) In group 2 implants, excluding the coronal part bone adaptation around the implants could be detected and the implants were well-extruded from the alveolar bone (Fig 2b) In group 3 however nearly half of each implant body remained exposed protruding out of the alveolar bone (Fig 2c)

Observation via CLM confirmed that Villanueva stained mature bone covered each implant in group 1 (Fig 3a) and that bone to implant contact was intimate around the coronal part of the implant Thick cortical bone having a smooth periosteal surface was also evident in another section 250 μm distal to the previous one (Fig 3a, *inset*) In group 2 bone to implant contact was fairly good around the apical two thirds of each implant However the bone crest showed craterlike defects at the neck region of the implants and thick bone was formed at the base of the sockets (Fig 3b) Similar features were characterized at the coronal part in another section 250 μm distal to the previous one (Fig 3b *inset*) In group 3 bone to implant contact was variable around the apical half of the implants, no bone regeneration occurred around the coronal half, and the base of the sockets was thicker than in the other 2 groups (Fig 3c) Craterlike defects between the bone crest and implants were present (Fig 3c *inset*)

Implant positions were not equivalent in the different groups at 90 days after placement (Figs 2 and 3) In group 1 the average apical distance was only 0 17 to 0 64 mm while in groups 2 and 3 respectively it was 0 44 to 0 9 mm and 0 91 to 1 28 mm (Fig 4 and Table 1), and the differences were significant (Table 1) These data suggest that the implants were partially exfoliated because of bone formation at the base of the socket as the usual socket healing procedure in groups 2 and 3 produced exfoliation of 0 31 mm and 0 4 mm respectively A significant

***Figs 3a to 3c*** *CLM images of sections cut sagittally from the mesiodistal direction Im = implant (original magnification ×20)*



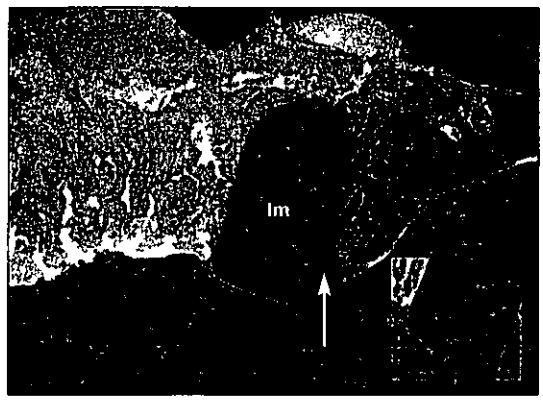




**Fig 3a** *(Above)* Group 1 implant shows bone regeneration with a wide range of bone to implant contact around the coronal part of the implant The inset indicates thick bone with a smooth periosteal surface *(arrowhead)* submerging the implant

**Fig 3b** *(Above right)* Group 2 implant shows the exposed coronal part of the implant and the bone crest that formed craterlike defects *(arrows)* Bone to implant contact is fairly good at the apical part of the implant and thick bone was formed at the base of the socket The inset shows similar features

**Fig 3c** *(Right)* Group 3 implant Nearly half of the implant is exfoliated beyond the alveolar bone (maxilla opposite of Figs 3a and 3b) The bone to implant contact is different from the mesial to the distal sides The inset shows the craterlike defects *(arrow)*

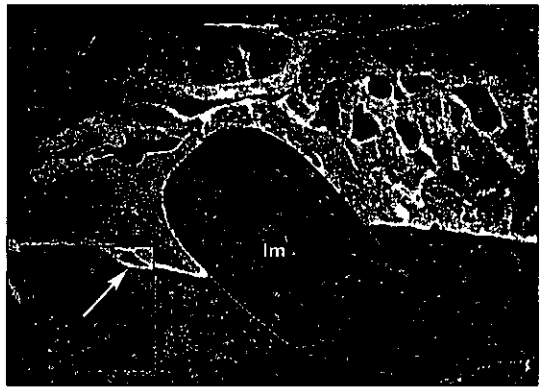



**Fig 4** Diagrams represent immediate implants inside the socket and regenerated bone after 90 days Three vertical lines (MN OP and QR) were drawn on an imaginary horizontal straight line (MOQ) along the upper border of the maxillary bone (base of the maxillary sinus) MN is the line touching the most mesial (x) point of the implant while OP and QR passed through or ended at the coronal edges of the implant Mx and Oy represent the apical distance between MOQ and the apical end of the implants in all groups while y P and zR represent the heights of the newly formed coronal bone that covered the implant in group 1

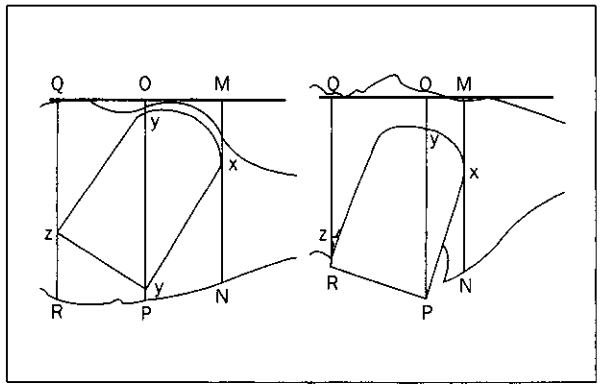



**Table 1 Regenerated Bone Height (in mm) and Implant Position in All Groups**

| | Measurement (mm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Group | Mx | xN | MN | Oy | y P | Qz | zR | QR |
| Group 1 | 0 64 | 1 18 | 1 82 | 0 17 | 0 18 | 1 26 | 0 6 | 1 86 |
| Group 2 | 0 9 | 0 88 | 1 78 | 0 44 | 0 | 1 82 | (–)0 3 | 1 51 |
| Group 3 | 1 28 | 0 52 | 1 8 | 0 91 | 0 | 1 84 | (–)0 4 | 1 44 |

Data represent the average of 3 animals from each group
$P < 05$ and $P \leq 001$ were considered significant while data on the respective items for rhBMP 2 groups were compared with those of the other 2 groups

amount of coronal bone was observed in group 1 only, and at 0.18 to 0.6 mm was approximately 30% of the total height (MN = 1.82 mm) (Table 1). On average, the alveolar bone crest level was 0.31 mm and 0.4 mm below the edge of the implants in groups 2 and 3, respectively. In group 1, the implant remained inside the socket probably because of the rhBMP-2–induced bone produced around the coronal part of the implant shortly after operation. A shorter apical distance (0.17 to 0.64 mm) indicating bone formation at the base of the socket possibly did not occur because of the implant being helped by quicker forming coronal bone.

## DISCUSSION

In the present experiment, as observed in previous study, rhBMP-2–induced bone formation at the coronal end of each socket kept the implant submerged in the socket, and this new bone remained unresorbed until the time of sacrifice at 90 days. In a previous report, it was documented that rhBMP-2 accelerated rat maxillary root socket healing so as to preserve alveolar bone volume (without implant).[11] In that study, rhBMP-2 induced a large amount of bone formation at the coronal end of the socket during 14 to 28 days after the operation, and the bone remodeled to a plane alveolar ridge by 84 days. In the present study, rhBMP-2–induced bone at the same location remained for a longer period and retained about 30% of the total bone height until 90 days. This result is in agreement with a recent experimental report, which indicated that significantly more bone formation occurred at rhBMP-2–treated sites within the perforations of dental implants compared to sites treated with the vehicle alone.[13] In the present study, the smooth periosteal surface and the small osteocyte lacunae resembling the adjoining alveolar bone indicated that the bone was mature and cortical. The implants that could easily be pulled out and did not have primary anchorage at the time of surgery were retained within the socket covered by newly regenerated bone in all samples in group 1. Apical distance between the implant apex and MOQ was shorter compared to other groups, about 0.4 mm on average (Table 1). Also, the thickness of apical bone in this group appeared to be the same as that observed in a fresh extraction socket in a previous experiment.[11] Thus, it might be suggested that rhBMP-2–induced bone helped the implant remain inside the socket during the integration period by restricting at least vertical movement. Perhaps a similar occurrence around submerged immediate implants without primary anchorage had not been demonstrated before.

Several reports have demonstrated the use of grafting materials or bone augmentation materials to support submerged immediate implants. However, significant enhancement of peri-implant bone regeneration around immediate implants was not shown in those experiments.[4,5] The rhBMP-2 might also have enhanced the bone regeneration so as to increase the range of bone-to-implant contact around the coronal part of the implant. In the no treatment group (group 3), the implants were pushed out of the sockets, possibly because no bone was formed at the coronal region. In addition, bone formation from the base of the sockets resulted in a risk of exfoliation of the implants. However, in group 2, a larger part of each implant remained inside the socket than was the case in group 3. The bone-to-implant contact appeared to be better as observed in CMR and CLM studies, perhaps because the mass of the carrier worked as a cover at the opening of a socket just after the operation.

In a previous study, it was also found that the carrier (PLGA/GS) was resorbed within 84 days when applied in rat maxillary root sockets.[11] The present rat model documented findings suggesting that further studies in larger animals or studies of an oral application of rhBMP-2 via PLGA/GS along with immediate implants would be worthwhile.

## CONCLUSIONS

Based on a previous study and data from 16 sockets of the present study, it can be concluded that rhBMP-2 accelerated bone formation around the immediate implants. A significant amount of bone was induced by rhBMP-2 at the coronal part of the immediate implant, and this bone helped to maintain the implant body inside the socket during the integration period in rats. This technique of rhBMP-2 application around immediate implants also appeared to be useful in maintaining alveolar bone height and may thus aid in the successful immediate placement of oral implants.

## ACKNOWLEDGMENT

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RESEARCH REPORTS
Clinical

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# Association between Serum Albumin and Root Caries in Community-dwelling Older Adults

## ABSTRACT

Recently associations between dental diseases and the general health condition have been reported The purpose of this study was to evaluate by serum albumin concentrations the relationship between the general health condition and root caries We randomly selected 763 individuals (600 70 year olds and 163 80 year olds) living in Niigata City Japan The variables body composition blood measurements daily nutrient intakes and root caries were measured The relationship between root caries and serum albumin concentration was evaluated The differences in serum albumin concentrations between subjects with untreated root caries (DT = 0 and DT ≥ 3) were 75 56 mg/dL in 70 year olds and 202 97 mg/dL in 80 year olds ($p < 0$ 05 ANOVA) The findings of the present study indicated that a relationship between root caries and serum albumin concentration in these elderly subjects is highly possible

**KEY WORDS** serum albumin root caries elderly people

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## INTRODUCTION

Disabilities in daily living occur frequently in elderly people because of inflammatory states or disorders Regarding oral health elderly people have few remaining teeth Dental caries including root caries has been shown to be significantly associated with the incidence of tooth loss (Hand *et al* 1991 Locker *et al* 1996)

Recently associations between dental diseases such as periodontitis or dental caries and the general health condition have been reported The possible role of periodontal infections as risk factors for systemic diseases such as coronary heart disease has attracted special attention (Genco 1996 Papapanou 1996) The composite dental index—combining caries, periodontitis, periapical lesions pericoronitis and edentulousness—was linked to ischemic events in patients with coronary heart disease (Mattila *et al* 1995) Furthermore, it has been shown that dental caries may be associated with immune response (Tenovuo *et al* 1990) Dental caries might be a risk marker or factor for the general health condition However the relationship between a dental disease such as root caries and the general health condition including nutrient intake infections or anthropometry is still unknown in elderly people

The purpose of this study was to evaluate the relationship between the so called general health condition and root caries In particular we adopted the serum albumin concentration as a criterion which shows us the general health condition Serum albumin levels may be an index of the severity of an underlying disease In addition a strong association between albumin level and mortality has been reported (Phillips *et al* 1989 Darnes and Ducimetiere 1990) Many conditions such as malnutrition inflammatory states liver diseases and renal diseases reduce serum albumin levels (Herrmann *et al* 1992) We evaluated the relationship between the serum albumin level and root caries

## MATERIALS & METHODS

Initially questionnaires were sent to all 6629 inhabitants aged 70 and 80 yrs old according to a registry of residents in Niigata City in Japan and they were informed of the purpose of this survey The response rate was 79 5% (3695 70 year olds 1578 80 year olds six age indistinct) Among them we randomly selected 763 (600 70 year olds 163 80 year olds) individuals to have approximately the same number *per* gender in each age We evaluated in the people who were examined in this study compared with all other residents the differences in the general health condition such as the number of cases of disease (heart disease blood disease liver disease kidney disease diabetes mellitus high blood pressure rheumatism respiratory disease lumbago allergies digestive disease cerebral apoplexy) from which the subjects had suffered the percentage of smokers and the percentage of people with trouble chewing Written informed consent was obtained from all subjects The protocol for this study was approved by the Ethics Committee of Niigata University School of Dentistry

**Table 1** Mean of the Number of Instances of Root Caries Biochemical Values Body Mass Index and Nutrient Intakes by Sex and Age

| | 70 year olds | | | | 80 year olds | | | | *P* value[b] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Males (N = 306) | | Females (N = 294) | | Males (N = 75) | | Females (N = 88) | | Gender | Age |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | | |
| Serum albumin (mg/dL) | 4303 95 | 273 20 | 4323 37 | 258 65 | 4163 89 | 331 58 | 4262 07 | 264 24 | ns[c] | < 0 001 |
| IgG (mg/dL) | 1485 19 | 302 96 | 1560 67 | 340 77 | 1595 31 | 338 02 | 1513 25 | 285 19 | ns | ns |
| IgA (mg/dL) | 333 86 | 144 90 | 298 38 | 111 91 | 351 43 | 129 39 | 321 79 | 123 47 | < 0 001 | ns |
| Body Mass Index | 22 13 | 2 76 | 22 64 | 3 10 | 21 74 | 2 92 | 22 35 | 2 81 | < 0 05 | ns |
| Fat intake (g/day) | 45 71 | 11 34 | 44 50 | 9 70 | 43 54 | 11 65 | 41 91 | 10 39 | ns | < 0 05 |
| Sugar intake (g/day) | 230 37 | 60 34 | 211 44 | 45 91 | 221 70 | 51 48 | 202 12 | 48 02 | < 0 001 | ns |
| Protein intake (g/day) | 53 90 | 11 83 | 52 51 | 9 26 | 52 64 | 10 54 | 50 50 | 9 76 | < 0 05 | ns |
| Untreated root caries[a] | 0 42 | 1 07 | 0 30 | 0 79 | 0 64 | 1 38 | 0 20 | 0 73 | < 0 01 | ns |
| Missing teeth[a] | 11 04 | 9 77 | 11 18 | 9 36 | 19 75 | 9 95 | 22 24 | 10 80 | ns | < 0 001 |
| Treated root caries[a] | 1 37 | 2 59 | 0 80 | 1 91 | 0 40 | 1 20 | 0 18 | 0 92 | < 0 001 | < 0 001 |

[a] Number *per* person
[b] *P* value by an analysis of variance
[c] ns = not significant

### Root Caries

Four trained dentists assessed the oral health conditions Dental clinical examinations were done by means of dental mirrors and WHO ball pointed periodontal probes under artificial light without bite wing radiographs Root caries was diagnosed according to WHO criteria (World Health Organization 1997) except for unerupted/unexposed roots and arrested lesions Root decay was defined when a lesion was detected on an exposed root surface and felt soft or leathery when probed For a single incidence of decay or for a filling affecting both the crown and the root the likely site of origin of the lesion was recorded as decayed or filled The examiners were calibrated by 18 volunteer patients in the University Hospital before and during the survey Interexaminer reliability for surfaces was assessed for the four examiners We calculated a kappa score using 5 codes (Sound Filled Decayed Filled [with decay] and Bridge abutment Special crown or Veneer/implant) The kappa values between each pair of examiners were 0 84 0 97

### Body Composition and Blood Measurements

Anthropometric evaluation included measurements of weight and height for the calculation of Body Mass Index In addition determinations of serum albumin IgG and IgA concentration were also made The serum albumin concentration was measured by a BCG method (Doumas *et al* 1971)

### Food Intake

Dieticians instructed participants on recording their own dietary intake for one day The interviewer provided each person with written directions and food models for recording food intake and reviewed the completed records with each subject Total daily nutrient intakes of sugar fat and protein from food were computed for those subjects

### Statistical Analysis

For descriptive data (serum albumin anthropometric measurements food intake biochemical measurements and root caries) statistical differences between age and gender were evaluated by an analysis of variance In addition the relationship between serum albumin concentration and the presence of untreated and treated root caries missing teeth Body Mass Index nutrient intakes and biochemical values was evaluated by an analysis of variance adjusted for age and gender For evaluation of the relationship between root caries and serum albumin concentration linear multiple regression analysis was performed As a dependent variable serum albumin concentration was used As independent variables we selected the independent variables which had $p$ values less than 0 05 according to the analysis of variance adjusted by gender and age for each variable

## RESULTS

We evaluated the differences in general health condition between the people who were examined in this study (EX) and all other residents (RE) The numbers of cases of disease which EX and RE had had previously were 1 50 (SD = 1 13) and 1 16 (SD = 1 16) for 70 year olds and 1 86 (SD = 1 39) and 1 32 (SD = 1 32) for 80 year olds respectively The percentages of smokers in EX and in RE were 19 5% and 22 3% for 70 year olds and 13 2% and 13 0% for 80 year olds respectively The percentages of people with trouble chewing in EX and in RE were 16 4% and 18 8% for 70 year olds and 16 6% and 25 1% for 80 year olds respectively There were no significant differences in the numbers of cases of disease the percentages of smokers and the percentages of people with trouble chewing between EX and RE by gender except the numbers of cases of disease in males aged 80 yrs (2 52 [SD = 1 41] for EX *vs* 2 04 [SD = 1 34] for RE $p < 0\ 05$ by $t$ test) and the percentages of people with trouble chewing in females aged 80 yrs (11 9% for EX *vs* 27 3% for RE $p < 0\ 01$ by chi square test)

In addition we compared the descriptive variables of subjects (Table 1) There were significant differences in IgA Body Mass Index sugar intake protein intake the presence of untreated root caries and the presence of treated root caries by gender by an analysis of variance All significant parameter levels except Body Mass Index were higher in males In addition serum albumin fat intake number of missing teeth and the presence of treated root caries were significantly associated with age by an analysis of variance All significant parameter levels except number of missing teeth were lower in

**Table 2** The Relation between Serum Albumin Concentration or Untreated Root Caries and Treated Root Caries, Missing Teeth, Body Mass Index, Biochemical Values and Nutrient Intake

| Parameters | Category | No of Subjects | Serum Albumin (mg/dL) Mean | SD | *P* value[b] | Untreated Root Caries[a] Mean | SD | P value[b] |
|---|---|---|---|---|---|---|---|---|
| Treated root caries[a] | 0 | 562 | 4289 57 | 278 15 | | 0 00 | 0 00 | |
| | 1 2 | 93 | 4282 80 | 260 28 | | 0 77 | 0 77 | |
| | ≥ 3 | 105 | 4321 91 | 279 76 | ns[c] | 1 06 | 1 06 | < 0 01 |
| Missing teeth[a] | 0 | 51 | 4337 26 | 264 55 | | 0 25 | 0 71 | |
| | 1 7 | 260 | 4291 92 | 278 95 | | 0 32 | 0 99 | |
| | 8 14 | 138 | 4293 48 | 265 05 | | 0 74 | 1 37 | |
| | 15 21 | 118 | 4233 90 | 286 81 | | 0 50 | 0 98 | |
| | 22 | 185 | 4319 46 | 274 16 | ns | 0 14 | 0 45 | < 0 01 |
| Body Mass Index | < 20 | 173 | 4243 20 | 262 71 | | 0 38 | 1 01 | |
| | 20 24 | 360 | 4296 09 | 265 97 | | 0 39 | 1 04 | |
| | > 24 | 228 | 4326 55 | 297 25 | < 0 05 | 0 33 | 0 85 | ns |
| IgG (mg/dL) | < 1000 | 22 | 4327 27 | 267 59 | | 0 05 | 0 21 | |
| | 1000 1900 | 643 | 4301 87 | 273 94 | | 0 37 | 0 97 | |
| | > 1900 | 89 | 4222 47 | 286 34 | < 0 05 | 0 51 | 1 18 | < 0 05 |
| IgA (mg/dL) | < 96 | 3 | 4033 33 | 321 46 | | 0 00 | 0 00 | |
| | 96 430 | 621 | 4302 09 | 274 06 | | 0 39 | 0 99 | |
| | > 430 | 130 | 4256 92 | 281 45 | ns | 0 34 | 0 94 | ns |
| Protein intake (g/day) | 1 (23 5 46 1)[d] | 186 | 4287 63 | 308 28 | | 0 31 | 0 88 | |
| | 2 (46 1 52 2) | 188 | 4296 28 | 288 16 | | 0 44 | 0 97 | |
| | 3 (52 3 59 2) | 186 | 4290 86 | 265 44 | | 0 23 | 0 64 | |
| | 4 (59 2 128 9) | 188 | 4297 87 | 240 98 | ns | 0 51 | 1 30 | ns |
| Fat intake (g/day) | 1 (16 5 37 2) | 188 | 4281 38 | 311 67 | | 0 37 | 0 97 | |
| | 2 (37 2 43 9) | 184 | 4310 33 | 278 47 | | 0 33 | 0 77 | |
| | 3 (44 0 51 6) | 188 | 4268 62 | 271 11 | | 0 30 | 0 84 | |
| | 4 (51 5 97 6) | 188 | 4312 77 | 238 64 | ns | 0 49 | 1 27 | ns |
| Sugar intake (g/day) | 1 (81 8 183 4) | 185 | 4280 00 | 300 87 | | 0 26 | 0 72 | |
| | 2 (183 5 213 1) | 188 | 4322 87 | 261 75 | | 0 43 | 1 06 | |
| | 3 (213 2-244 6) | 188 | 4275 00 | 282 01 | | 0 31 | 0 82 | |
| | 4 (244 7 574 2) | 187 | 4294 65 | 258 35 | ns | 0 50 | 1 22 | ns |

[a] Number *per* person
[b] *P* value by an analysis of variance adjusted for age and gender
[c] ns = not significant
[d] 1 = first 2 = second 3 = third and 4 = fourth quartiles

80-year-olds

The Fig shows the differences in the distributions of serum albumin concentrations according to the presence of untreated root caries (DT) in subjects who were divided into 3 categories (DT = 0, DT = 1 or 2, DT ≥ 3) The subjects with many instances of DT had a significantly lower serum albumin concentration by an analysis of variance adjusted for gender and age ($p < 0\ 05$) The differences in the serum albumin concentrations between subjects with DT = 0 and those with DT ≥ 3 were 75 56 mg/dL in 70-year-olds and 202 97 mg/dL in 80-year-olds The maximum number of instances of DT was 7 for 70-year-olds (n = 2) and 6 for 80-year-olds (n = 3) The differences in the serum albumin concentrations between subjects with DT = 0 and subjects with the highest levels of DT were 173 38 mg/dL for 70-year-olds and 298 17 mg/dL for 80-year-olds In addition, the subjects with a low Body Mass Index and a high IgG concentration had a significantly lower level of serum albumin by an analysis of variance adjusted for gender and age ($p < 0\ 05$, Table 2) In contrast, the subjects with a large number of instances of treated root caries and a high level of serum IgG concentration had a significantly greater number of instances of untreated root caries ($p < 0\ 01$, $p < 0\ 05$, Table 2), even if there was no increase in the number of missing teeth In

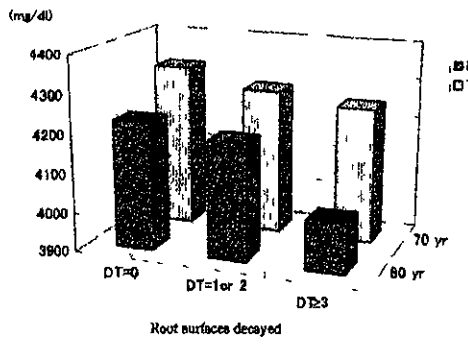


**Figure** Serum albumin concentrations according to number of instances of untreated root caries by age The subjects with more than 3 instances of untreated root caries had significantly lower serum albumin concentrations by an analysis of variance adjusted for age and gender ($p < 0\ 05$) DT = number of instances of untreated root caries The n for each cell of data was DT = 0 (n = 484 for 70 year olds n = 131 for 80 year olds), DT = 1 or 2 (n = 92 for 70 year olds, n = 24 for 80 year olds) and DT ≥ 3 (n = 24 for 70 year olds n = 8 for 80 year olds)

particular, the serum IgG concentration was significantly associated with both the serum albumin concentration and the number of instances of untreated root caries The level of the serum IgG concentration and the number of instances of untreated root caries increased, while the level of the serum albumin concentration decreased

For evaluation of the relationship between root caries and serum albumin concentration, 4 variables (number of instances of untreated root caries, age, Body Mass Index, and concentration of IgG) were selected for the independent variables of the final model The result of linear multiple-regression analysis by the final model is presented in Table 3 The number of instances of untreated root caries was significantly associated with the concentration of serum albumin adjusted for age, Body Mass Index, and concentration of IgG ($p < 0.05$)

## DISCUSSION

According to the results of our study of the differences in general health condition between EX and RE, there was a small difference in the number of cases of disease, the percentage of smokers, and the percentage of people with trouble chewing Therefore, we thought that the subjects in this study were representative of the community In contrast, the R2 by the multiple-regression analysis is low (Table 3) This means that the amount of variance explained by the multiple-regression analysis is low, which indicates that although the 4 independent variables had significant probability, there are other explanatory factors We should keep in mind the limitations of the present study

In this study, the number of untreated teeth (DT) was a significant factor associated with serum albumin concentration The differences in the serum albumin concentrations between subjects with DT = 0 and those with DT ≥ 3 were 75 56 mg/dL in 70-year-olds and 202 97 mg/dL in 80-year-olds ($p < 0.05$) Furthermore, there was a big difference in the serum albumin concentrations between those with DT = 0 and those with DT = maximum 173 38 mg/dL for 70-year-olds and 298 17 mg/dL for 80-year-olds

Hypoalbuminemia may be directly linked to adverse effects A strong association between albumin levels and mortality has been reported Especially, Shibata *et al* (1991) investigated the relationship between serum albumin and mortality in a 10-year longitudinal study of 421 community residents aged 69-71 yrs In that report, subjects who were divided into four groups according to the quartile of serum albumin levels (-4 1, 4 2-4 3, 4 4-4 5, 4 6+, g/dl) had significantly different survival rates There was even an evident difference in survival rates between the first and second quartiles Our study indicates that the difference in serum albumin levels between the number of instances of untreated root caries shown in the subjects might have a meaningful influence on the subjects' general health status However, we could not find a significant relationship between the number of instances of treated root surfaces and the serum albumin concentration Regarding root surface filling, a previous study reported that 45% of restorations were placed because of decay, while 55% were done for cervical wear/sensitivity (Walls *et al*, 2000) Because it is unclear what rate is due to untreated root caries *vs* cervical wear, it might be difficult to evaluate the relationship between the treated teeth and the serum albumin concentration Furthermore, we could not find any significant relationship between the number of missing teeth and the serum albumin concentration There are many studies that evaluated the factors for tooth loss, which indicated that not only caries but also periodontitis was a major factor for tooth loss Many other local factors, such as abutment teeth for removable partial dentures, increased the tooth loss risk (Hirotomi *et al*, 2002) It might be difficult to evaluate the relationship between missing teeth and the serum albumin concentration, especially in elderly people

The background of the effect of serum albumin value on mortality is not well-understood We thought of two conceivable possibilities about that relationship One is the influence of a chronic disease, the other is the influence of nutrient intake In this study, the serum IgG concentration was significantly associated with both the serum albumin concentration and number of instances of untreated root caries The level of the serum IgG concentration and the number of instances of untreated root caries increased, while the level of the serum albumin concentration decreased If a decrease of the serum albumin concentration was influenced by the subject's malnourished state, the serum IgG concentration might, conversely, show a tendency to decrease The significant relationship between the serum albumin concentration and number of instances of untreated root caries in this study might be influenced by chronic infectional disease rather than by nutritional condition

The serum IgG level increased with the presence of caries (Parkash *et al*, 1994) The nature of the human immune response to dental caries suggests that *Streptococcus mutans* amd serum antibodies may play a major role in pathogenesis Furthermore, there was a significant relation between the serum albumin and the serum IgG concentrations (Goubran Botros *et al*, 1996) The serum albumin concentration may fall due to a variety of infections, including root caries, with an increase of the serum IgG concentration However, it is difficult to discuss this causality by only this study Further studies should be conducted to find the relationship between root caries and serum albumin, taking into consideration not only root caries but also systemic infectional diseases

In contrast, serum albumin value might be a good guideline

**Table 3** Multiple Linear Regression and Associated *P* values

| | Dependent Variable Serum Albumin (mg/dL) | | | | |
|---|---|---|---|---|---|
| Independent Variable | Coef | Std Err | *P* value | [95% CFI] | |
| Untreated root caries[a] | 20 97 | 10 09 | < 0 05 | 40 77 | 1 17 |
| Age | 8 95 | 2 43 | < 0 001 | 13 71 | 4 18 |
| Body Mass Index | 11 50 | 3 40 | < 0 001 | 4 82 | 18 18 |
| IgG (mg/dL) | 0 08 | 0 03 | < 0 01 | - 0 14 | 0 02 |
| Constant | 4814 79 | 196 17 | < 0 001 | 4429 68 | 5199 90 |

$p < 0.001$, $R^2 = 0.04$

[a] Number per person

for a subject s nutritional condition Certainly some reports have indicated that dietary intake influences serum albumin (Magagnotti *et al* 2000 Giordano *et al* 2001) However correcting the malnourished state might be more difficult in elderly people than in younger ones The rate of albumin synthesis in elderly subjects might not be sensitive to changes in protein intake (Walrand *et al* 2000) There was a report that synthesis speed of albumin in the liver in elderly people is not influenced by the ingestion of protein and that serum albumin might be influenced by aging itself (Shibata *et al* 1991) However there was a significant relationship between serum albumin concentration and Body Mass Index in this study It has been reported that low Body Mass Index becomes a risk factor for all cause mortality (Shirasaki 1996 Ishii *et al* 1998 Landi *et al* 1999) and the risk of daily activity limitation (Allison *et al* 1997) Because of a good relationship between Body Mass Index and nutrient intake we could not completely deny the relationship between serum albumin concentration and nutrient intake We could not find any significant relation between nutrient intake and both the serum albumin concentration and the number of instances of untreated root caries in this study

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原　著

# 高齢者の根面う蝕の有病状況と歯冠う蝕との関連

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廣富　敏伸　　山賀　孝之　　花田　信弘*　　宮﨑　秀夫

概要　本研究の目的は　高齢者の根面う蝕の有病状態に関する記述統計的分析を行い　さらに根面う蝕と歯冠う蝕の有病状態との関連について分析を行うことである

調査対象者は　新潟市内在住の70歳600名である　分析対象者は　このうちの有歯顎者544名である　有病状況は　根面う蝕の所有者率　一人平均根面う蝕歯数　部位別　歯面別の分布で評価した　関連分析では　歯冠う蝕歯数群別の根面う蝕の所有者率および一人平均歯数を求め　次に根面う蝕の有無を目的変数にしてロジスティック回帰分析を行った

分析の結果　根面う蝕（根面DF）は男性の56 9%　女性の53 5%が所有し　平均根面う蝕歯数（根面DFT）は男性1 81（SD=2 41）　女性1 41（SD=1 93）だった　根面未処置う蝕（根面D）はそれぞれ21 7　19 8%が所有し　平均根面未処置う蝕歯数（根面DT）は0 46（SD=1 10）　0 32（SD=0 81）だった　部位別の分布は　上顎では大歯　下顎では小臼歯に最も多く　歯面別では　頬側に最も多かった　歯冠う蝕との関連分析では　歯冠う蝕歯数が多い者ほど根面う蝕の所有者率が高く　根面DFTの平均が高かった　ロジスティック回帰分析にて口腔内のほかの要因を調整しても　歯冠う蝕歯数は根面う蝕の有無と有意（オッズ比1 08　p<0 001）に正の関連があった　以上の結果から　高齢者の根面う蝕の所有者率は高く　また　歯冠う蝕歯数は根面う蝕の所有の有無に関連があることが示された

索引用語　根面う蝕　高齢者　疫学調査

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## はしめに

近年の高齢化に伴い　歯の喪失をはしめとする歯科疾患と全身的健康状態との関連が注目を集めている　そのようななか　咀嚼能力と全身の健康状態との関連など　いくつかの調査が報告されてきている[1,2]　十分な機能歯の保有により咀嚼能力が維持され　全身の健康状態を良好に保つと考えられる　わが国では　近年　高齢者における保有歯の増加傾向がみられ　一人平均現在歯数は平成5年に65〜69歳で13 2歯　70〜74歳で10 8歯だったのが　平成11年にはそれぞれ16 8歯　12 7歯になった[3,4]

しかし　一方で高齢者では残存歯における歯根露出が多く認められ[5,6]　根面でのう蝕発生率の上昇が危惧される　根面う蝕は歯の形態上　治療が困難な場合も多く　その後の歯の喪失と強く関連しているといわれている[7,8]　根面う蝕が高齢者の口腔の健康　さらに全身の健康状態に与える影響は大きいと考えられる[9]

残存歯数の増加と歯肉退縮に伴う根面う蝕の危険性が予測されるにもかかわらず，わが国における根面う蝕の疫学調査はあまり多くない　これまでに18歳以上を対象に調査が行われ　根面う蝕の有病者率は18 2〜30 3%[10-13]　根面未処置う蝕の所有者が4 7〜13 7%[10,11]　あるいはRoot Caries Indexが0 5〜17 4[12-14]と報告されている　しかし　高齢者を対象とした調査はさらに少なく[10,13]　根面う蝕の口腔内における有病状態など詳細な情報は不足している　また　従来の高齢者を対象としたう蝕の調査では　歯冠と根面をまとめた形での報告が多かった　根面う蝕と歯冠う蝕は　口腔細菌の酸産生により硬組織が脱灰し　う窩を形成するという点では類似した疾患である　しかし　その成り立ちについては臨界pHが異なるため[15]　う蝕の発生部位を歯冠と根面に分けて評価することが望ましい　さらに　高齢者では現在歯数や全身状態が年齢によって大きく変化することを考慮すると　根面う蝕の分析は各年齢層に分けて行う必要がある　これまでの調査では対象者の年齢幅が広く　各年齢層の対象人数が少なくなる問題があった　本研究では，同年齢を対象者に選択して分析に十分な人数を確保した

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本研究の目的は　高齢者の根面う蝕の有病状態に関する記述統計的分析を行い　さらに根面っ蝕と歯冠う蝕の有病状態との関連について分析を行うことである

## 対象および方法

### 1　調査対象者

1998年4月，新潟市内在住の70歳（1927年生）全員（4 542名）に質問紙を郵送し　健康状態　現在歯数の自己申告　健診受診の希望などについて事前調査を実施した[16]　その結果　3 695名(81 4%)から回答が得られた　そのうち　拒否者を除き男女同数になるように無作為に抽出し　最終的に600名を調査対象者とした　調査対象者には施設入居者は含まれていなかった

調査の実施にあたっては　市内の地区センターなどを会場とし　口腔診査　内科健診　運動機能調査および日常生活習慣に関する質問紙調査[17]を調査項目とした　599名が口腔内診査を受け　このうち有歯顎者は554名(92 5%)だった　本調査は新潟大学歯学部倫理委員会の承認を得て行われた

### 2　測定方法

口腔内診査については　4名の診査者が人工照明下のもと簡易ヘノトを使用して仰臥位で行った　っ蝕の診査は　照明付きミラー　CPI探針（金属製）を用いて行われ　診査を妨げる歯面のプラークを探針または綿球を用いて除去した　エアーシリンジ　X線写真は使用しなかった　根面っ蝕の検出にあたっては　セメノトエナメル境界またはクラウンの辺縁より1mm以上の露出が認められた根面を対象とし　1歯を4歯面（近心　遠心　頬側　舌側）に分けて診査　記録した　診断基準として　<健全>　<WSDによる充填>　<っ蝕による充填>　<未処置っ蝕>　<未処置っ蝕を伴う処置>　<根面露出なし>の6コートを使用した　根面の未処置っ蝕については　WHOの基準に準して　歯肉縁上の根面に限局していて　CPI探針で触れたときノフト感あるいはさらつき感があるものとした[18]　2次っ蝕または同一歯面上に未処置っ蝕と充填があるものを<未処置っ蝕を伴う処置>として　未処置っ蝕のみの歯面とは区別して記録した　充填については　<っ蝕による充填>と<WSDによる充填>を形態により区別して記録した　すなわち　充填の形態が円形のものを根面っ蝕による充填　角度（鋭角から直線に近い鈍角）のついた形態[19]のものをWSDによる充填とした　判定の際には隣在歯や反対側の歯の状態も参考にした　判別困難な場合は<っ蝕による充填>とした　未処置っ蝕または充填が歯冠と根面の両方にまたがっている場合は　その発生部位と思われるほうを記録し　発生部位の判断が困難なときは　歯冠と根面の両方に記録した　また，未処置う蝕　充填の1/3以上が隣接する歯面へ広がっている場合は複数歯面に記録した

歯冠については　歯単位で記録し，WHOの分類コートにクラウンを加えた　<健全>　<外傷>，<充填>　<クラウン>　<ブリッジの支台歯>　<未処置う蝕>　<未処置う蝕を伴う処置>の7コートを使用した　歯冠における未処置っ蝕の基準は　明らかなっ窩，脱灰　浸食されたエナメル質　軟化底　軟化壁が探知できる小窩裂溝　平滑面である[18]

4名の診査者は大学附属病院予防歯科診療室を受診した18名（848歯面）を対象にして　診査者間の基準の一致状況を測定した　診査者間のKappa値は根面では0 60 0 79　歯冠では0 80-0 95であった

唾液中のmutans streptococci（SM）およびlactobacilli（LB）の菌量レベルの定量には　Dentocult SM strip®およびDentocult LB Dip Slide®（Orion Diagnostica Espoo Finland）を使用した　口腔内診査の前にパラフィンワックスを使用して30秒間予備咀嚼させた後　3分間の刺激唾液を採取した　唾液量を測定後に　通法に従いコロニーレベルを評価した　2名の診査者がそれぞれの対象者のSM　LBの菌量レベルを評価した　キノトのマニュアルにしたがい　SM　LBのいずれもグレート0　1　2　3の4段階に評価した　判定が一致しなかった場合には再度判定を行い　最頻値をもって代表値とした　それでも評価が決定しない場合には協議を行い　いずれかのグレートを採用した

### 3　分析方法

分析対象者は歯を1歯以上所有している有歯顎者554名（男281名　女273名）である　分析対象歯には　残根または根面キャップを除いたが　第三大臼歯は含めた

根面の未処置っ蝕（根面D）については　根面の<未処置っ蝕>と<未処置っ蝕を伴う処置>と定義した　根面の処置されたっ蝕(根面F)は　<っ蝕による充填>とし，<WSDによる充填>は含めなかった　また　歯冠部の未処置っ蝕(歯冠D)には歯冠の<未処置っ蝕>と<未処置っ蝕を伴う処置>を採用した　また　歯冠の処置されたっ蝕(歯冠F)には　<充填>　<クラウン>および<ブリッジ支台歯>を含めた　診査結果に基づき　根面DFの所有者率　1人平均根面DF歯数(根面DFT)　根面Dの所有者率および1人平均根面D歯数(根面DT)を算出した　さらに　根面っ蝕の部位別（上下顎別の大臼歯　小臼歯　大歯　切歯）歯面別(近心　遠心　頬側　舌側）の分布を露出歯根面に占める根面D歯面数（根面

DS) 根面F歯面数(根面FS)の割合て評価した 歯冠部う蝕の評価にあたっては，歯冠DF歯数(歯冠DFT)歯冠D歯数（歯冠DT）の一人平均歯数および所有者率を用いた

次に 根面う蝕と歯冠う蝕の関連を分析した 最初に対象者を歯冠DFT数に基つき0歯群，1〜7歯群 8〜13歯群 14歯以上群の4群に分類した 0歯群以外の3群については人数分布か均一になるよっにカノトオフナイントを決定した その後，それぞれの群単位て根面DFの所有者率および1人平均根面DFTを求め $\chi^2$検定および分散分析を行った 次に 口腔内のほかの要因の影響を除くため 根面う蝕の有無を目的変数に 性 歯冠DF歯数 現在歯数 露出歯根面 部分床義歯の使用(なし/あり)，SMレヘル(クレート1以下/2以上) LBレヘル(クレート1以下/2以上)および刺激唾液流量（0 5ml/分以上/未満)を説明変数に加えてロジスティノク回帰分析を行った 説明変数のうち刺激唾液流量については人数分布による25ハーセンタイルをカノトオフポイントに設定した

分析にはUSA Stata Corporation製のSTATA 6[20]を使用した

## 結 果

分析対象者となった有歯顎者554名のうち 98%か交通機関を利用して独力て外出できる状態（厚生省寝たきり判定基準 J1）であった 一人平均現在歯数は18 82（SD=8 14）て 性差はなかった（表1）

表2に根面DF Dの所有者率およひ一人平均DFT DTを示す 根面DFについては男性の56 9% およひ女性の53 5%か所有し，根面Dについてはそれぞれ21 7 19 8%か所有していた いすれも性差はなかった 一人平均根面DFTは男女それぞれ1 81（SD=2 41）1 41（SD=1 93）で 根面DTはそれぞれ0 46（SD=1 10） 0 32(SD=0 81)たった いすれも男性のほうか有意（p<0 05）に多かった

図1 図2に根面う蝕の露出歯根面に占める割合およひ露出歯面数を部位別に示す 根面う蝕の割合は上顎では犬歯か17 5%と最も高く 切歯（14 5%） 小臼歯（11 2%） 大臼歯（7 4%）の順に低くなり（図1） 下顎ては小臼歯か11 5%と最も高く 次いて大歯（10 1%） 切歯（6 1%） 大臼歯（5 7%）の順に低くなった（図2） 未処置う蝕については下顎の切歯か最も低かった 図3に根面う蝕の露出歯根面に占める割合および露出歯面数

表1 調査対象者数および分析対象者数と平均現在歯数

| | | 男 | 女 | 計 |
|---|---|---|---|---|
| 調査対象者数 | | 306 | 293 | 599 |
| 有歯顎者の割合 | | 91 8% | 93 2% | 92 5% |
| 分析対象者 | 人数 | 281 | 273 | 554 |
| | 平均現在歯数（S D） | 19 16 (8 26) | 18 48 (8 02) | 18 82 (8 14) |

表2 根面のDF D所有者率および一人平均DFT DT

| | | 男 | 女 | p値 |
|---|---|---|---|---|
| DF | 所有者率 | 56 9% | 53 5% | NS |
| | 平均値（SD） | 1 81 (2 41) | 1 41 (1 93) | p<0 05 |
| D | 所有者率 | 21 7% | 19 8% | NS |
| | 平均値（SD） | 0 46 (1 10) | 0 32 (0 81) | p<0 05 |

$\chi^2$検定 t検定

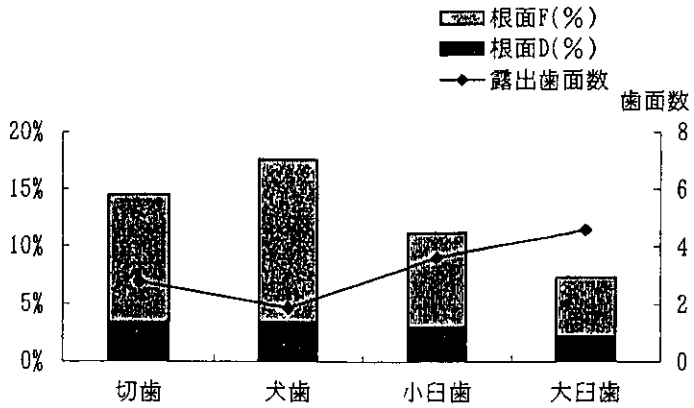


図1 根面う蝕の露出歯根面に占める部位別の割合および露出歯面数（上顎）

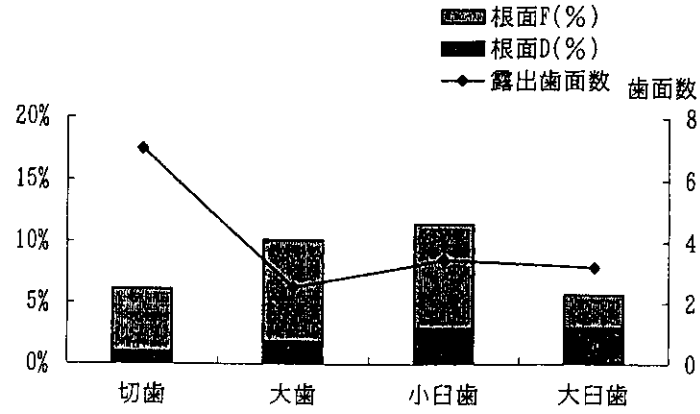


図 2　根面う蝕の露出歯根面に占める部位別の割合および露出歯面数（下顎）

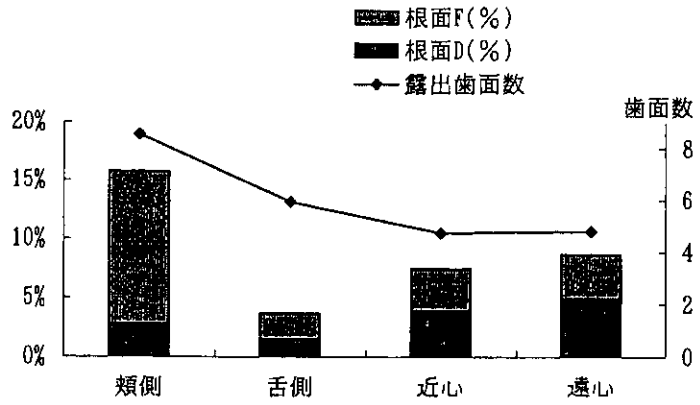


図 3　根面う蝕の露出歯根面に占める歯面別の割合および露出歯面数

を歯面別に示す　根面う蝕の割合は頬側が 15 8%と最も高く　次いで遠心 (8 7%)　近心 (7 4%)　舌側 (3 7%) の順に低くなった　未処置う蝕は遠心が最も高く　次いで近心　頬側　舌側の順に低くなった

表には示していないが　歯冠 DF は男性の 95 0%　女性の 99 6%が所有し　女性のほうが有意 ($p<0$ 01) に高かった　歯冠 D はそれぞれ 18 1%　15 4%が所有し　男女差は有意ではなかった　一人平均歯冠う蝕歯数は　歯冠 DFT が男女それぞれ 9 49 (SD=5 99)　11 70 (SD=5 80) で女性のほうが有意 ($p<0$ 001) に多かった　歯冠 DT はそれぞれ 0 32 (SD=0 87)　0 21 (SD=0 57) で有意差はなかった

表 3 に歯冠う蝕歯数別にみた根面う蝕の所有率および一人平均歯数を示す　歯冠う蝕を多く所有している者のほうが根面う蝕の所有者率が高く　歯冠う蝕を 14 歯以上所有している者では　根面う蝕の所有者率が 61 9%だった　これらの根面う蝕の所有者の分布は $\chi^2$ 検定において有意差 ($p<0$ 01) が認められた　歯数についても同様な傾向が見られ　歯冠う蝕を多く所有している者ほど根面う蝕を多く所有していて　分散分析においても有意であった

表 4 にロジスティック回帰分析の結果を示す　口腔内のほかの要因を調整しても　歯冠う蝕歯数は根面う蝕の有無と有意 ($p<0$ 001) に正の関連があった　そのほか有意 ($p<0$ 05) に関連していたのは露出歯根面　部分床義歯の有無の 2 変数だった

## 考　察

分析の結果　70 歳の高齢者における根面 DF の所有者率は男 56 9%　女 53 5%であった　従来より報告されている調査をまとめると　わが国の高齢者を対象とした調査では，根面 DF の所有者率は 22～30%であり　本調査結果と比較し　低い値であった[10 13]　一方　海外における調査では，所有者率でみるとアメリカの 65 歳以上の黒人

表 3　歯冠う蝕歯数別にみた根面う蝕の所有者率および一人平均根面う蝕歯数

| | | | 根面 DFT | | | | |
|---|---|---|---|---|---|---|---|
| | | 人数 | あり (%) | p 値 | 平均値 | SD | p 値** |
| 歯冠 DFT | なし | 15 | 26 7 | 0 001 | 0 67 | 1 29 | 0 006 |
| | 1-7 | 165 | 44 4 | | 1 22 | 1 92 | |
| | 8-13 | 197 | 54 0 | | 1 73 | 2 30 | |
| | 14- | 177 | 61 9 | | 1 93 | 2 30 | |
| | Total | 554 | 55 2 | | 1 61 | 2 19 | |

*$\chi^2$検定　　分散分析

表 4　根面う蝕の有無を目的変数としたロジスティック回帰分析の結果

| 説明変数 | 区分 (0/1) | 回帰係数 | 標準誤差 | p 値 | オッズ比 | 95%信頼区間 |
|---|---|---|---|---|---|---|
| 歯冠 DF 歯数 | | 3 82 | 0 02 | <0 001 | 1 08 | 1 04 1 12 |
| 現在歯数 | | −0 78 | 0 02 | 0 434 | 0 98 | 0 95 1 02 |
| 露出歯根面数 | | 5 55 | 0 01 | <0 001 | 1 04 | 1 02 1 05 |
| 部分床義歯 | (なし/あり) | 2 84 | 0 50 | 0 005 | 2 02 | 1 24 3 29 |
| SM | (Grade 1 以下/2 以上) | 0 67 | 0 23 | 0 503 | 1 15 | 0 77 1 71 |
| LB | (Grade 1 以下/2 以上) | 1 59 | 0 29 | 0 113 | 1 39 | 0 92 2 10 |
| 刺激唾液流量 | (0 5 ml/分以上/未満) | 1 11 | 0 29 | 0 265 | 1 29 | 0 83 2 00 |

目的変数　根面う蝕の有無 (0　なし　1　あり)
分析対象者　542 名
説明力 (Pseudo $R^2$) = 0 089
Prob > $\chi^2$ = 0 000

を対象とした 36%[21]からスウェーテンの 55〜75 歳の住民を対象とした 85〜93%[22]まで大きな差が認められた 諸外国で行われた調査のなかには，診断に X 線写真を使用したり[22]，あるいは診査前に機械的な歯の清掃を行ったものかあり[23] これらては有病者率か高く 調査方法か有病者率に与える影響は大きいといわれている 本調査の診査ではこのとちらも行わなかったか 口腔内診査を実施する際には簡易ヘノトを用いて仰臥位を取り 診査を妨ける歯面のプラークについては可能な限り除くようにした このよっな診査方法を用いることにより多くの根面う蝕の検出を可能にしたと考えられる しかし 一方で WHO の基準て用いる CPI プローブについては ノフト感の検出か歯科用探針に比へると明らかに劣ると報告されている[24] したかって 歯科用探針を本調査で用いるとさらに根面う蝕の有病率か高くなる可能性も考えられる

高齢者を対象とした本調査において 根面う蝕は半数以上の者か所有していた 今後，高齢者ては保有歯の増加か予測されることから 根面う蝕の増加か危惧される また 根面う蝕は発生部位またはっ蝕の進行状態によっては歯冠全体の処置か必要になることもある これらのことから 高齢者の歯の健康を維持するために 根面う蝕の発生予防は今後の重大な課題てある

次に露出歯面数に占める根面っ蝕の割合の分布を部位別 歯面別に評価した 部位別では下顎は小臼歯と大歯に高く 上顎は大歯と切歯に高かった ほかの調査では 下顎ては大臼歯 および小臼歯に高いと報告されているものか多いか[22 25 26] 上顎では 大歯と切歯[25 26]や 大臼歯[22]に高いという報告かあり 上顎では分布の傾向か一致していない 本調査ではほかの調査と異なり下顎大臼歯の根面う蝕の割合か低かった この原因は 調査対象を高齢者のみに限ったためと思われる ほかの調査[22 25 26]て報告されているように 下顎大臼歯は根面っ蝕の発生か多く そのため早い時期に歯を喪失すると考えられる 本調査ても残存歯率か 35 8%と部位別にみて最も低い値たった したかって 高齢期に残存している下顎大臼歯は根面っ蝕のリスクの低い歯か残っていると考えられる そのため高齢者のみを対象とした本調査では 根面っ蝕か少なくなったと推測される

歯面別の分布ては 頬側か最も高く 舌側か最も低かった これは 過去の調査と同様の傾向であり 根面っ蝕

は頬側に多く発生すると考えられる[22,27] しかし 根面の充填はう蝕たけてなくWSDなとの非う蝕性の欠損か原因で充填される場合かある 根面の充填をすへて根面う蝕に含める評価方法ては 根面う蝕の有病状況か実際よりも過大干価されることか指摘されている[28] イキリスの歯科医に対して行った調査ては 充填歯面のうち,45%は根面う蝕 55%はCervical wearまたはSensitivityであったと報告されている[28] 本研究においてはこの占を考慮して 充填原因をう蝕のものとWSDによるものに分けて記録を行った 充填歯面のうち44 5%か<WSDによる充填> 55 5%か<う蝕による充填>と判断された 分析にはう蝕によると判断された充填のみを根面う蝕に加えた

また 未処置う蝕の割合の分布を歯面別にみると遠しおよひ近しに高く 隣接面の根面う蝕の約半数を占めていた これは隣接面のう蝕か処置されにくいことを示しその背景には 対象者本人か隣接面のう蝕に気つきにくいことか考えられる また 歯科医師か見落としている可能性も考えられ 高齢者の診療においては隣接面の精査は不可欠であり X線撮影や清掃後に診査を行うなとの対策か必要と思われる

歯冠う蝕と根面う蝕の有病状況の関連についての報告はわか国ではこれまてにみられないようてある 本研究では 歯冠う蝕歯数か多い者ほと根面う蝕を所有している者の割合か高く 根面う蝕歯数も多いことか示された 歯冠う蝕と根面う蝕の関連か示された背景には 根面う蝕と歯冠う蝕か共通の原因から発生している場合と,歯冠う蝕か根面う蝕を誘発している場合の2通り考えられる 本調査から因果を明らかにすることは不可能てあるか 少なくとも歯冠う蝕の予防は根面う蝕の予防につながると考えられる いすれにせよ 小児期から始まる永久歯のう蝕予防は 高齢期の根面う蝕の予防に対しても有効であると考えられる

今回行ったロンスティノク回帰分析ては 細菌の量に関する2変数に関連か認められなかった 口腔細菌と根面う蝕の関連を評価するには口腔細菌を質的 量的の両方からみる必要かあり 今後さらなる検討か必要と考える

本調査対象者は有歯顎者率か92 5%,一人平均現在歯数は17 8歯であった これは平成11年度歯科疾患実態調査[4]の70歳の有歯顎者率か85 4% 一人平均現在歯数か14 3歯てあるのと比へても高い数値である 本調査では 調査に先立って 母集団てある新潟市在住の70歳全員に郵送による現在歯数の質問紙調査(回収率79 5%)を行った 調査対象者の現在歯数の自己評価値と口腔診査値の関連を分析し 母集団における現在歯数の推定値を算出したところ 調査対象者は母集団より現在歯数か2 6〜3 9歯多いと推測された[29] 母集団の現在歯数か全国平均値と比較して多い背景には,調査対象地区か都市部であったことか影響していると考えられる また 母集団より調査対象者の現在歯数か多くなった原因には,対象者に施設入居者かいないこと 健診を受診しても健康上の差し支えのない者であったことかあけられる これは対象者の98%か交通機関を利用して独力で外出できる状態(厚生省寝たきり判定基準 J1)であったことから示されている

以上,本研究ては 高齢者の根面う蝕の有病状況,歯冠う蝕の有病状況との関連について分析を行った 根面う蝕は半数以上の者か所有しており 根面う蝕の所有者率は高いことか示された また 歯冠う蝕歯数は根面う蝕の所有の有無に関連かあることか示された

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# Root Caries Prevalence and Association between Root Caries and Coronal Caries in the Elderly

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**Abstract** The purpose of this study was to investigate the prevalence and intraoral distribution of root caries in the elderly and to identify the association between root caries and coronal caries Six hundred noninstitutionalized adults aged 70 years in Niigata Japan were examined for their oral status and general health status A total of 544 subjects identified as dentate was available for assessment

The prevalence of root caries was evaluated as the percentage of the subjects with one or more root caries and the mean number of teeth with root caries The intraoral distribution was evaluated as the mean percentage of exposed root surfaces affected by root caries in terms of tooth surface (buccal lingual distal mesial) and tooth group (incisor canine premolar molar) In the analysis of the associations subjects were divided into 4 groups according to the number of coronal caries first and then the prevalence of root caries was evaluated in each group Next logistic regression analysis where the dependent variable was one or more root caries and the independent variables including the number of teeth with coronal caries was performed

The percentage of male subjects with one or more root caries (DF) was 56 9% and that of female subjects was 53 3% The mean number of root DFT was 1 81 (SD=2 41) per person for males and that for females was 1 41 (SD=1 93) per person respectively As for untreated root caries (D) the percentage of male subjects with one or more root D was 21 7% and that of female subjects was 19 8% The mean number of root DT for males was 0 46 (SD=1 10) per person and that for females was 0 32 (SD=0 81) per person The tooth type most commonly affected by root caries in the maxilla was canine and in the mandible it was premolar The percentage of exposed root surfaces affected by root caries was 17 5% and 11 5% respectively As for tooth surface distribution the buccal surfaces were the most commonly affected with a percentage of 15 8% The mean number of teeth with root caries and the percentage of subjects with root caries increased with the number of coronal caries Logistic regression analysis indicated that the prevalence of coronal caries was significantly associated with that of root caries (odds ratio=1 08 $p<0$ 001) after adjusting for other oral variables

In conclusion the results suggest that the prevalence of root caries in the elderly was high and the prevalence of coronal caries was associated with root caries prevalence

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**Key words** **Root caries Elderly Epidemiology**

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# Application of Phosphoryl Oligosaccharides of Calcium (POs-Ca) for Oral Health

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Abbreviations

POs, phosphoryl oligosaccharides, POs-Ca, phosphoryl oligosaccharides of calcium, Ca, calcium P phosphate BSA bacterial saccharifying α-amylase, GA, glucoamylase, BLA, bacterial liquefying α-amylase PPA, porcine pancreatic α–amylase, HSA human saliva α amylase TAA Taka amylase A Glc-6-P D-glucose-6-phosphate, $6^2$-phosphoryl maltose O-6-phosphoryl-α-D-glucopyranosyl-(1_4)-O-α-D-glucopyranose, $6^3$-phosphoryl maltotriose, O-6-phosphoryl-α-D-glucopyranosyl-(1_4)-O-α-D-glucopyranosyl-(1_4)-D-glucopyranose, $6^2$-phosphoryl maltotriose, O-α–D-glucopyranosyl-(1_4)-O-6-phosphoryl-α-D-glucopyranosyl-(1_4)-D-glucopyranose $6^3$-phosphoryl maltotetraose, O-α-D-glucopyranosyl-(1_4)-O-6-phosphoryl-α-D-glucopyranosyl-(1_4)-O-α-D-glucopyranosyl-(1_4)-D-glucopyranose $6^4$-phosphoryl maltopentaose, O-α-D-glucopyranosyl-(1_4)-O-6-phosphoryl-α-D-glucopyranosyl-(1_4)-O-α-D-glucopyranosyl-(1_4)-O-α–D-glucopyranosyl-(1_4)-D-glucopyranose, $3^3$-phosphoryl maltotetraose O-α–D-glucopyranosyl-(1_4)-O-3-phosphoryl-α-D-glucopyranosyl-(1_4)-O-α-D-glucopyranosyl-(1_4)-D-glucopyranose, $3^4$-phosphoryl maltopentaose O-α–D-glucopyranosyl-(1_4)-O-3-phosphoryl-α-D-glucopyranosyl-(1_4)-O-α-D-glucopyranosyl-(1_4)-O-α–D-glucopyranosyl-(1_4)-D-glucopyranose