

Original

Relationship between Oral Condition and Bone Density from Results of Public Health Screening Examinations - Application in Clinical Setting

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Abstract: We have been studying the relationships between results of osteoporosis screening examinations and those of dental health checkups, and have reported the relationship between number of remaining teeth and bone density in the calcaneus (%YAM). Further, that relationship was also examined using Functional Tooth Evaluation Score (FTES) results, which we found able to quantify and numerically express oral conditions. In the present study, we examined the relationship between the mean results of FTES and bone density in the calcaneus by age, and used the results for clinical application. The subjects for this study were 235 women of 30's-70's.

Following are the results for subjects aged 50 – 64 years old.

(1) The tendencies for changes in mean FTES and bone density in the calcaneus by age were very similar. Mean FTES and mean bone density in the calcaneus showed a positive correlation. ($p < 0.01$).

(2) Subjects who demonstrated a lower FTES than expected on the basis of the age were referred to an orthopedic specialist for measurements of bone density, and some were diagnosed with osteoporosis. As a result, our findings suggested that FTES can be utilized for screening of osteoporosis.

Key words: Bone density (%YAM), Clinical application, Functional tooth evaluation score (FTES), Oral condition, Osteoporosis

Introduction

Recently, the relationships between medical disease and dental disease, particularly periodontal disease, have been studied, with the field referred to as periodontal medicine¹⁻⁷⁾. In the present periodontal medicine study, we focussed on osteoporosis, as others have also investigated and analyzed its relationship with periodontal disease⁸⁻¹⁸⁾. However, there are no known reports that have compared medical results with dental results obtained from public health screening examinations.

We are conducting a series of studies on the relationships between the results of an osteoporosis screening examination and those of a dental health checkup carried out in a large population living in the same municipality. In our previous study, the relationship between number of remaining teeth and bone density in the calcaneus (%YAM) was reported¹⁹⁾, and we also found Functional Tooth Evaluation Score (FTES) to be an effective means of numerically expressing and quantifying oral conditions from the mass screening examinations in detail^{20,21)}. In the present

report, changes in the mean results of FTES and bone density in the calcaneus were studied according to age, and the results applied clinically.

Subjects and Methods

Subjects

In Mitsu-cho, Ibo-gun (Mitsu-cho, Tatsuno-city, as of October 1, 2005), located in the southwest part of Hyogo Prefecture, various public health examination screenings known as 'Whole Town Health Checkups' are performed in May of each year for local residents with 20 years old and above. The examinations include a dental health checkup as well as a basic health checkup and cancer screening. Further, in late May an osteoporosis screening examination is scheduled on a different day for the same residents. For the present study, we selected subjects from those who had participated in dental health checkup and osteoporosis screening examinations associated with Whole Town Checkups during the 5-year period from 1997 to 2001. Since osteoporosis is a disease found largely in females, most of the subjects who underwent osteoporosis screening were women. Thus, a total of 235 women were examined in the present study.

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To analyze the dental health checkup results, a detailed chart was used to record dentition (dental formula). The number of remaining teeth and FTES were used as indices for expressing oral conditions numerically. As for the results of osteoporosis screening, we used quantitative ultrasound (QUS) results for the calcaneus. Bone density in the calcaneus is expressed as the percent of the young adult mean (%YAM). Based on our results, changes in mean FTES and mean bone density in the calcaneus were determined, and their relationships compared by age.

Table1. Evaluation score of each tooth.

Tooth condition	Score (Point)
Intact Tooth (Caries free)	10
Questionable Caries	9
filling with Resin or Inlay etc	8
Crown or Abutment of Bridge	7
Secondary Caries	6
Cries	5
Mobility of Tooth (Medium)	4
Pontic of Bridge	3
Artificial Tooth of Denture	2
Remaining Root	1
Missing Tooth or Mobility tooth (Severe)	0

The number of remaining teeth is a simple means of rating and quantifying oral conditions. In a previous study, we used FTES results to reflect oral conditions in greater detail²⁰. For calculating FTES, each tooth was scored, as shown in Table I. The full score was 280 points when all 28 teeth excluding the third molar were considered to be intact. FTES was then calculated as the ratio of the score to the full possible score using the following formula:

$$FTES = (\text{points acquired}) \div 280 \times 100.$$

(Statistical Analysis)

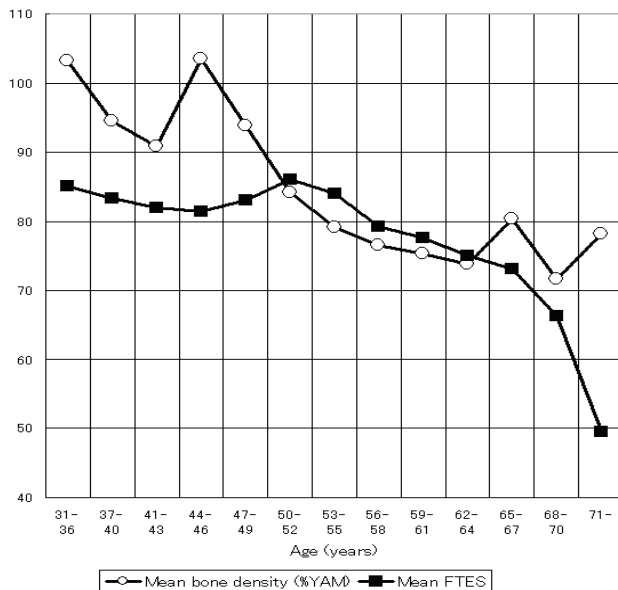


Fig.1-1 Mean FTES and mean bone density according to age.

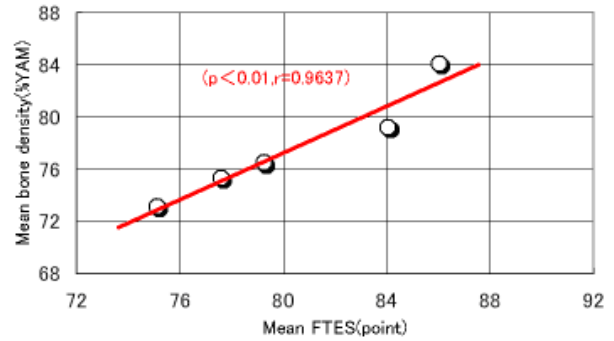


Fig.1-2 Mean FTES and mean bone density. (From 50 to 64 years old)

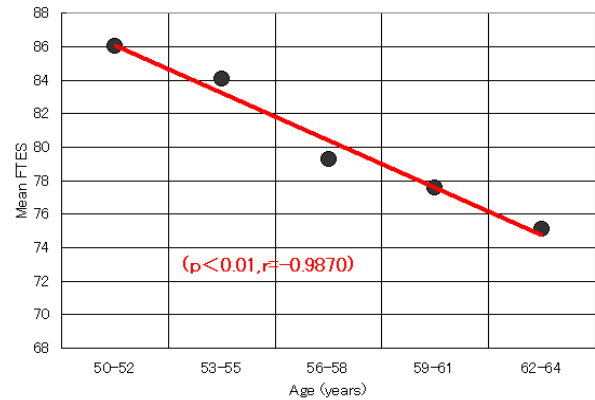


Fig.1-3 Mean FTES according to age.

Statistical analyses were performed using SPSS for Windows v. 11.0 (SPSS Inc. Chicago, IL). A result was considered statistical significant when $p < 0.05$.

Results

1. Changes in mean FTES and bone density in the calcaneus

At first we calculated regression line with age and FTES. Furthermore, we calculated regression line with age and bone density.

We considered whether these two regression lines which we calculated originally were parallel by ANCOVA (analysis of covariance). As a result, it was judged that a cline coefficient of both lines was the same ($p < 0.005$). Therefore we reviewed a change by age of FTES and bone density more in detail.

Changes in the results of mean FTES and bone density in the calcaneus by age with 3-year intervals are shown in Figure 1-1. For subjects aged 50 to 64 years old, the values showed similar decreasing tendencies. The correlations between mean FTES and bone density in the calcaneus by age class (from 50 to 64 years old) are shown in Figure 1-2. Both values demonstrated a strong correlation with age and mean bone density in the calcaneus was observed to be from 73% to 84% YAM, a range in which osteopenia is a concern. As shown in Figure 1-3, for the 5 age groups from 50 to 64 years old, 5 points of the mean FTES scores were arranged straight. Based on these findings, the following relational expression was obtained, $Y = -0.943X + 134.169$ ($p < 0.01$,

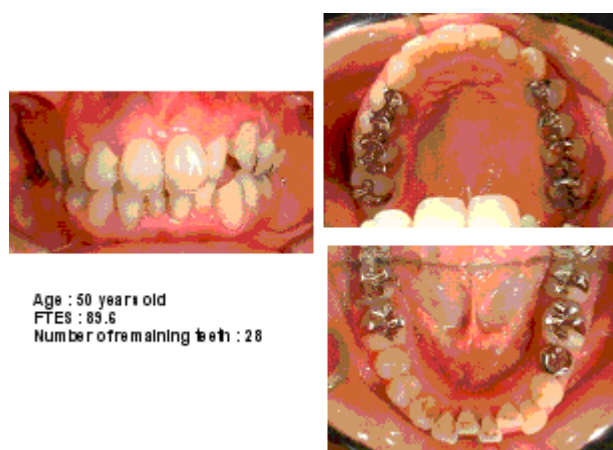


Fig.2-1 Clinical case (50 years old).



Fig.2-2A Clinical case (52 years old).

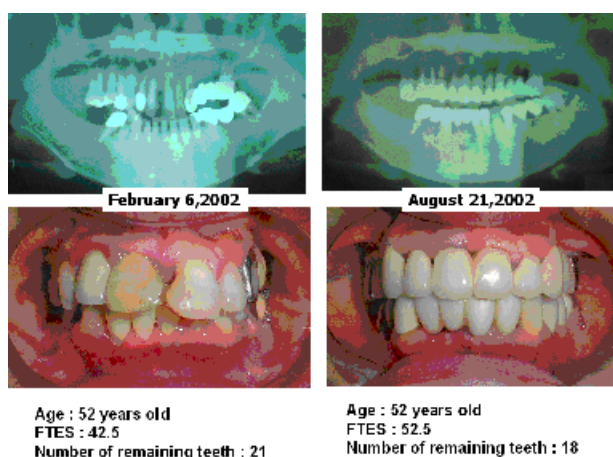


Fig.2-2B Clinical case (52 years old).

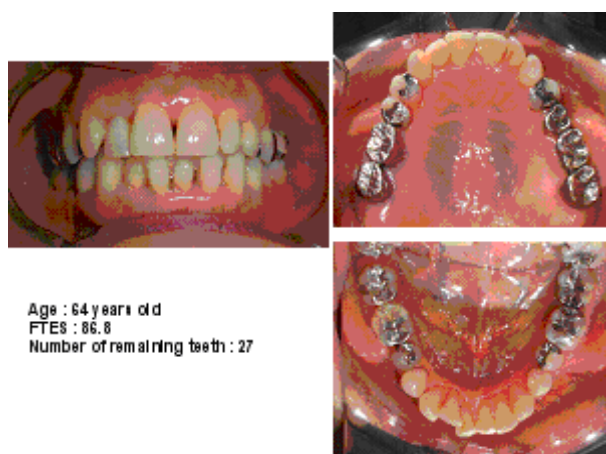


Fig.2-3 Clinical case (64 years old).

$r=-0.9870$), where $Y=FTES$ and $X=age$.

2. Clinical application

We used FTES clinically on the basis of the relational expression between age and FTES noted above. The subjects tested were originally referred to other medical professionals, primarily orthopedic specialists.

(A) Female subjects aged 50 to 60 years old

Figure 2-1 shows the oral condition of a 50-year-old woman. On the left side is the frontal view, while the right shows the dentition in the upper and lower jaws. Her FTES was 89.6 points. During treatment for periodontal disease, we informed the subject regarding periodontal medicine, and she expressed interest in osteoporosis and asked us to determine her bone density. When we used the relational expression written above, FTES was calculated to be 87.0 points, while the FTES value for actual oral condition was 89.6 points. Since the actual FTES was higher than the speculated FTES, we considered that there was no suspicion of osteopenia or osteoporosis. The patient was referred to an orthopedic specialist for a detailed examination, which found no

abnormality, as her bone density at the distal one-third of the radius was 0.642 g/cm^2 and 99% YAM.

The oral condition of a 52-year-old woman is shown in Figure 2-2A, 2-2B. Figure 2-2A shows the frontal view at the time of the first visit (February 6, 2002) in a panoramic X-ray image, as well as the dentition in the upper and lower jaw. Figure 2-2B shows a panoramic X-ray image taken at a regular health checkup (August 21, 2002) and an image taken at the first consultation for comparison. FTES was calculated on the basis of age to be 85.1 points, using the relational expression. At the time of the regular checkup, an FTES of 52.5 points was obtained on the basis of actual oral conditions, which was significantly lower than the calculated FTES of 85.1 points. Therefore, we suspected osteoporosis. The patient was advised to have bone density determined, for which she visited her family physician. She was diagnosed as needing a detailed examination, as her bone density in the calcaneus was determined to be 57 for stiffness and 62% YAM. The patient was referred to the orthopedic clinic.

(B) Female subjects aged 60 to 64 years old

Figure 2-3 shows the oral condition of a 64-year-old woman.



Fig.2-4 Clinical case (61 years old).

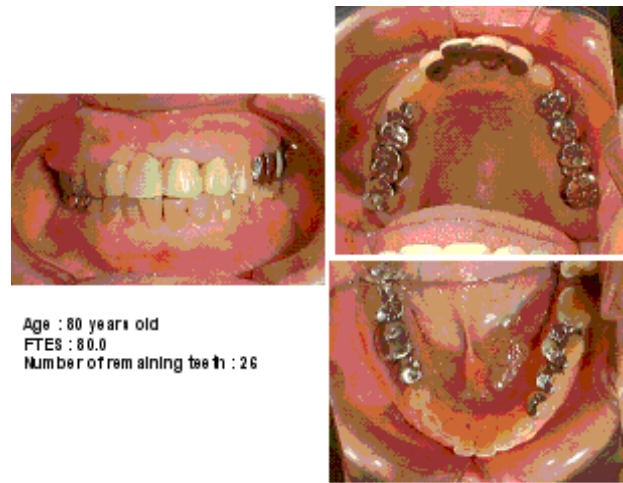


Fig.2-5 Clinical case (80 years old).

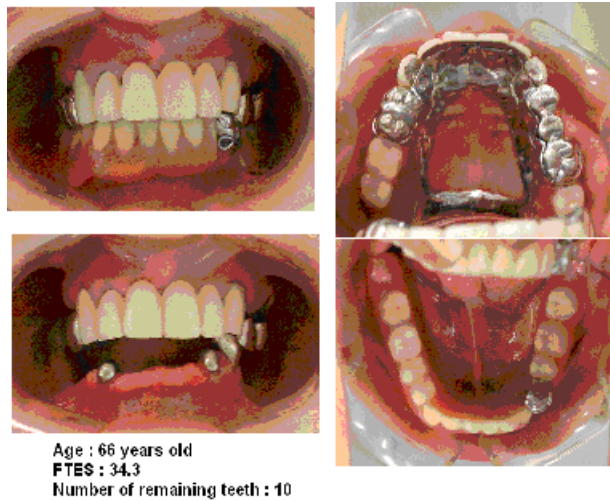


Fig.2-6 Clinical case (66 years old).

Her actual FTES based on oral conditions was 86.9 points. FTES calculated on the basis of age using the above-mentioned relational expression was 73.8 points. Since the actual oral condition score was higher, the patient was considered to be free from suspicion of osteopenia and osteoporosis. We provided her with information regarding the relationship between dental disease and medical disease, as well as that the relationship between osteoporosis and periodontal disease, and she underwent an osteoporosis screening examination in 2002. At that time, bone density in the calcaneus was determined to be 84 for stiffness and 92% YAM, and the patient was diagnosed to have no abnormality.

Figure 2-4 shows the oral condition of a 61-year old woman. The upper left image shows the frontal view at the time of the first visit (April 20, 2002), with her partial denture removed, while the upper right shows the frontal view taken while wearing the partial denture. The lower left shows the frontal view at the end of the treatment without partial denture (August 23, 2002) and

the lower right is the frontal view when wearing the new partial denture. At the end of treatment, her age was 61 years and FTES was 37.5 points. FTES was calculated based on age to be 76.6 points using the above-mentioned relational expression. However, a significantly lower actual FTES of 37.5 was obtained on the basis of her oral condition, which was considered indicative of osteoporosis, and the patient was referred to an orthopedic specialist for suspicion of osteoporosis. Those results showed bone density at the distal one-third of the radius to be 0.413 g/cm², or 64% YAM, which led to a diagnosis of osteoporosis, after which she received treatment as an outpatient.

(C) Other subjects

Figure 2-5 shows the oral condition of an 80-year-old woman. Her FTES was 80.0 points. We gave the patient information on the relationship between the number of remaining teeth and osteoporosis while she underwent treatment for caries. At that time, she was coincidentally receiving treatment for a sprained thumb at an orthopedic clinic and she became interested in undergoing a bone density measurement. The patient had been excluded from our FTES estimation on the basis of age, as she was out of the range of 50 to 64 years old. When we applied the relational expression, it revealed an FTES of 80.0 points, which was equivalent to an age of 57.4 years. Accordingly, we concluded that she had no concern for osteoporosis, though we referred her to an orthopedic specialist for a detailed examination. Her bone density at the distal one-third of the radius was determined by DXA to be 0.543 g/cm² or 79% YAM, which led to a diagnosis of no osteoporosis.

Figure 2-6 shows the oral condition of a 66-year-old woman at the end of treatment. The upper and lower left photos show the frontal view with and without her partial denture, respectively. The upper and lower right photos show the dentition of the upper and lower jaws, respectively, with the partial denture in place. Her FTES was 34.3 points. The patient had been excluded from

our FTES estimation on the basis of age (for 2 years older). However, FTES was determined to be 71.9 points, while the score based on her actual oral condition was significantly lower at 34.3 points, which was considered to indicate suspicion of osteoporosis. She was referred to an orthopedic clinic with suspicion of osteoporosis and bone density at the distal one-third of the radius was determined to be 60% YAM, which led to a diagnosis of osteoporosis. She received treatment and medication on an outpatient basis.

Discussion

1. Changes in mean FTES and bone density in the calcaneus by age

The changes in mean FTES and mean bone density in the calcaneus showed similar decreasing tendencies for subjects aged 50 to 64 years old in the present study (Fig. 1-1). Accordingly, the correlations between those values were examined by age, with the results shown in Figure 1-2. Mean FTES and mean bone density in the calcaneus showed a strong positive correlation of $r=0.9637$ ($p<0.01$), and mean bone density in the calcaneus was within a range of 73% to 84% YAM. Based on these results, we concluded that bone density in the calcaneus could be estimated from FTES for subjects aged 50 to 64 years old. In addition, we considered that once FTES was obtained, bone density in the calcaneus could be calculated with the expression $Y=0.8974X+5.4919$ (Fig. 1-2). The mean bone density in the calcaneus values were in the range of 73% to 84% YAM for our subjects aged 50 to 64 years old, which were near the level of 79% YAM when osteopenia becomes a concern. Thus, it we speculated that subjects with a low FTES would have a low bone density in the calcaneus, and osteopenia and osteoporosis should be suspected.

As shown in Figure 1-3, mean FTES was determined for 5 age groups between 50 and 64 years old, and the 5 results for those groups were arranged straight. From those, the relational expression $Y=-0.943X+134.169$ ($p<0.01$, $r=-0.9870$) was obtained, where $Y=FTES$ and $X=age$. Accordingly, it was considered that mean FTES could be calculated on the basis of age for subjects between 50 and 64 years old.

Our findings also suggested that bone density in the calcaneus could be estimated as lower than mean bone density using FTES, when FTES for the actual oral condition was lower than mean FTES estimated on the basis of age. As noted above, we considered that the level was highly likely to be 79%YAM or below. Thus, for subjects aged 50 to 64 years old, we concluded that when the FTES for actual oral condition is lower than mean FTES estimated on the basis of the age, actual bone density in the calcaneus will be lower than mean bone density in the calcaneus, indicating a suspicion of osteopenia and osteoporosis.

2. Application in Clinical Setting

Mean FTES estimated on the basis of age calculated with the relational expression $Y=-0.943X+134.169$ ($Y=FTES$, $X=age$)

We compared estimated FTES values and those obtained on the basis of actual oral condition. Subjects who demonstrated an actual FTES lower than estimated FTES and who were interested in periodontal medicine (especially in regards to osteoporosis) were referred to an orthopedic specialist. Of those, some were diagnosed with osteoporosis on the basis of bone density.

Our findings suggest that FTES can be utilized for screening. During evaluation of the results of clinical examinations and screening, it is expected that the validity of the results and ratio of overlooked conditions will vary depending on the cut-off levels. Further, it is also considered that cut-off level might have a relationship to the number of detailed examinations required and success rate²²). Additional investigations with a greater number of clinical cases and further study on the validity of such diagnostic examinations are necessary to determine the relationship between FTES for actual oral condition and mean FTES estimated by age, for evaluations of patients suspected of having osteopenia and osteoporosis and to determine the cut-off level.

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