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The Effects of Tooth Extraction on Cortical Thickness and Bone Mineral Density of the Mandible: Evaluation with Computerized Tomography

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Abstract: The cortical thickness of the mandible (CTM) and its bone mineral density may be affected by tooth extraction. There is little knowledge of how the number of teeth in the mandible affect the cortical thickness and bone mineral density of the mandible in 2 different parts. The purpose of this study was to demonstrate whether there is any relationship between the number of teeth extracted and the cortical thickness and bone mineral density of the mandible. A total of 64 cases were evaluated in this study. The patients were divided into four groups. Group 1 consisted of 24 patients who had not been subject to tooth extraction from the mandible. Group 2 consisted of 19 patients who had 11-15 teeth. Group 3 consisted of 12 patients who had 1-10 teeth and Group 4 consisted of 9 patients who had no teeth. The CTM and bone mineral density at the mandibular cortex (BMDC), spongiosa (BMDS) and lumbar spine (BMD VER) were calculated by quantitative computed tomography (QCT). The CTM and the bone mineral density of the cortex (BMDC) of the mandible showed significant decreases in Groups 1 to 4. The most significant decrease was observed in the CTM. No relations between the BMDS and the number of teeth extracted were found. The males exhibited greater values than age-matched females. The BMD VER also affected the bone mineral status of the mandible. The findings suggest that the CTM is the most important index affected by tooth extraction. BMDC decreased with the decreasing value of the bone mineral content of the lumbar spine and the increasing level of tooth extraction from the mandible. The males exhibited greater CTM and BMDC than age-matched females.

Key Words: Bone mineral density, mandible, lumbar spine, quantitative CT

Introduction

The mineral content of cortical bone in the mandible is likely to be related to the mineral content of the skeleton. Tooth extraction causes continuous and irreversible bone reduction at the mandible (1-4). This results in residual ridge resorbtion and a significant loss of alveolar bone. There is a higher percentage of cortical bone in the basal portion of the mandible than in the alveolar process. Therefore, the basal portion of the mandible is mostly affected by systemic factors (2).

The goal of this study was to determine whether there is any relations between the number of teeth extracted, the CTM and the bone mineral density of mandible in the 2 different portions.

Materials and Methods

Dental examination was performed on 64 patients from 1996 to 1999. After their mandibular status had been determined, the patients were divided into four different groups. Group 1 consisted of 24 patients who had experienced no tooth extraction from the mandible. Group 2 consisted of 19 patients who had 11-15 teeth. Group 3 consisted of 12 patients who had 1-10 teeth and Group 4 consisted of 9 patients who had no teeth.

All the patients were checked for diseases that can affect the mineral status of the bones. Patients who exhibited signs of endocrinologic, hormonal or metabolic disorders on physical, laboratory and radiologic examinations or who had a history of corticosteroid use were excluded from the study.

After the dental examination, the patients were subjected to computerized tomography (CT). For standardization, first, a lateral scanogram of the mandible was taken in the CT evaluation. Then, a line traversed parallel to the mandible corpus and angulus mandible was drawn. Axial CT sections parallel to this line were taken. The slice thickness and inter-slice gap were 3 mm in all the patients. All the sections of the patients were recorded. With the same window settings, the cortical thickness of the mandible (CTM) was calculated from the outer to the inner side in three portions (right, mid and left). Finally, the thickness was calculated as the mean value.

The bone mineral density of the mandibular cortex (BMDC) and spongiosa (BMDS) was calculated separately in different three portions by quantitative computerized tomography (QCT) in the same slice as cortical thickness was calculated. Then the mean value of these three calculations was recorded.

The bone mineral density in the spine (BMD-VER) was also calculated by QCT. First, a lateral scanogram of the thoracicolumbar spine was taken. Three axial slices parallel to the thoracic-11, lumbar-1 and lumbar-2 vertebrae corpus were taken and three measurements were made. The estimated value was the mean value of these three calculations.

The mean value and standard deviation of each measurement were calculated for each sex and group. According to the distribution of data, a simple two-way analysis of variance was performed. The Pearson correlation coefficient was calculated in order to determine possible association between the various parameters.

Results

There were 13 males and 11 females in Group 1, 11 males and 8 females in Group 2, 4 males and 8 females in Group 3, and 5 males and 4 females in Group 4. The average age in each group is given in the Table 1. The average values of BMDC, BMDS, BMD-VER, CTM are also given in this table according to group and sex. The BMDC and CTM decreased in groups 1 to 4 (Figs. 1 and 2). The statistical differences between the groups and sexes were significant (p=0.000, p=0.002, simple factorial ANOVA). The CT and BMDC of the mandible were significantly affected by the number of teeth extracted (p=0.001). BMDC and BMD-VER also displayed statistically significant differences between the groups and sexes. BMDC and BMD-VER decreased significantly with advancing age. However, there was no statistically significant difference between BMDS, sex and group (p=0.29, p=0.13 simple factorial ANOVA). There was a positive correlation between BMD-VER, CTM, BMDC and age (Pearson correlation coefficient). There was no correlation between BMDS and any of the other 5 parameters.

Discussion

The measurements of CTM and the bone mineral content of the mandible displayed statistically significant differences between the sexes and groups. These values were greater in the men than in the women. The number of teeth in the mandible significantly affected the bone mineral status and CT of the mandible. Both CT and BMDC gradually decreased in Group 1 to Group 4. The bone mineral content of the lumbar spine in females was also lower than that in age-matched men. The number of

Table 1. Mean and standard deviations of BMDC, BMDS, BMD-VER (g/cm3), CTM (mm), and age in relation to groups and sex.

Group	Sex	BMDC	BMDS	CTM	BMD-VER	AGE
1	M	1468.9+186.5	211.3+74.5	3.61+0.32	694,8+146.8	29.46+9.6
	F	1408.9+195.2	205.7+123.7	3,43+0.56	608.47+145.32	29.36+7.4
2	M	1455.4+296.2	215.5+88.6	3.45+0.55	608.39+231.52	47.64+12.9
	F	1370.1+164.4	164.4+79.92	3.13+0.48	421.83+191.45	48.16+13.1
3	M	1340.9+143.4	198.7+64.3	3.14+0.39	530.80+212.59	58.2 +3.4
	F	1288.0+261.7	199.3+109.2	2.18+0.48	414.05+109.04	57.4+9.3
4	M	1285.8+243.8	307.5+140.98	2.69+0.3	510.05+54.98	63.5+4.13
	F	1095.3+220.2	252.32+102.39	2.32+0.23	327.88+20.02	62.75+9.4

M: male, F: Female, BMDC: Bone mineral density of cortex, BMDS: Bone mineral density of spongiosa, CTM: cortical thickness of mandible, BMD-VER: Bone mineral density of lumbar vertebrae

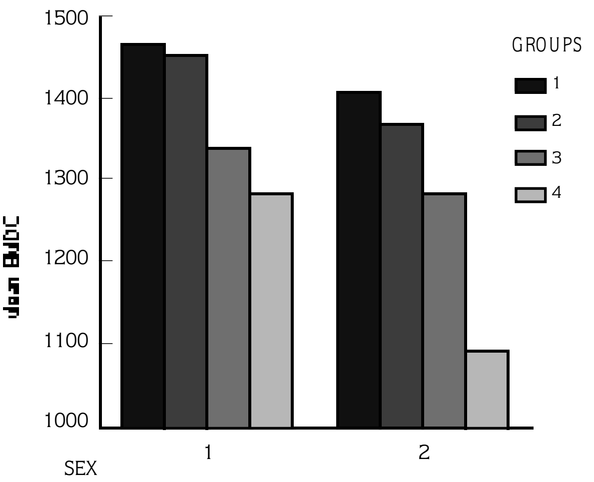

Figure 1. The correlation between BMDC and groups and sex. BMDC: Bone mineral density of mandibular cortex, Sex, 1: male, 2: female

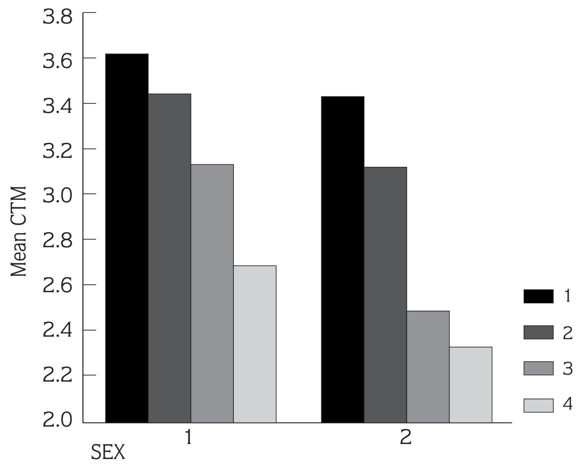

Figure 2. The correlation between CTM and group and sex. CTM: Cortical thickness of mandible, Sex 1: male 2: female

teeth in the mandible was also higher in the men compared with the age-matched women. The correlation analysis of the bone mineral content of the mandible and lumbar spine showed a tendency toward a decrease with advancing age and decreasing number of teeth in both sexes. The extraction of results in a decrease in the moment of resistance and support function. The cancellous portion of the mandible decreases and the inner trabecular bone increases (3). As a result, the cortical thickness decreases. The thicker the bone, the higher the measured density is (4). The bone mineral content of the mandibular spongiosa is not affected by the bone mineral content of the skeleton and the number of teeth in the mandible, but the thickness of the spongiosa increases with the decreasing size of the cancellous portion. The trabecular portion of the bones is made up of various amounts of fat, mineral and protein. The protein and fatty components of trabecular bone are affected by many systemic factors.

A number of factors affect the bone mineral content and cortical thickness of bones. These are systemic and regional factors. Most known systemic factors are hormonal, metabolic, endocrinologic and dietary factors. Regional factors are especially important in local parts of the body. Muscle function, the number of teeth and the duration of tooth extraction affect the bone status of the mandible.

Several different approaches have been utilized to quantify the bone mineral content of the skeleton. The cortical thickness can be calculated in conventional radiographs. This usually involves direct measurement of the inner and outer diameters of the cortex. One major limitation of this method is the failure to show the inner and outer parts clearly in conventional radiographs. However, CT is an excellent way to distinguish the inner and outer cortex (5).

QCT is unique amongst methods of measurement in providing separate estimates of trabecular and cortical bone BMD as a true volumetric mineral density in g/cm^3 (5). The concomitant measurement of the bone mineral content of the lumbar spine with the same technique provides more valuable information about the correlation of the general status of the skeleton and mandible.

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