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Elderly women with oral exostoses had higher bone mineral density

Takayuki Hosoi[1], Tomohisa Yoda[2], Masatsune Yamaguchi[2], Hitoshi Amano[3], and Hajime Orimo[1]

[1] Endocrinology Section, Tokyo Metropolitan Geriatric Center, 35-2 Sakaechou, Itabashi-ku, Tokyo 173-0015 Japan
[2] Department of Dentistry and Oral Surgery, Tokyo Metropolitan Geriatric Center, Tokyo, Japan
[3] Department of Pharmacology, School of Dentistry, Showa University, Tokyo, Japan

Abstract We examined the relationship between two opposite phenomena in elderly bone, bone loss (osteoporosis) and excessive bone formation (oral exostosis). We recruited, randomly, 44 female subjects without any conditions known to affect bone metabolism. The subjects were examined for exostosis, and bone mineral density (BMD) was measured by dual-energy X-ray absorptiometry. The Z score of the BMD was calculated; this is the deviation from the weight-adjusted average BMD of each age. Subjects with palatal tori ($n = 15$) had a higher femoral BMD than controls ($n = 14$) (0.580 ± 0.213 vs -0.271 ± 0.182; $P = 0.0054$). The subjects with palatal tori ($n = 12$) also had a higher BMD than controls ($n = 12$) at the radius (0.417 ± 0.235 vs -0.533 ± 0.294; $P = 0.0194$). In addition, subjects with mandibular tori ($n = 13$) had a higher femoral BMD than controls ($n = 14$) (0.569 ± 0.242 vs -0.271 ± 0.182; $P = 0.0097$). These results suggest that some common mechanisms are involved in the elevation of skeletal BMD and the occurrence of oral exostoses.

Key words osteoporosis · bone mineral density · oral exostosis · torus palatinus · *LRP5*

Introduction

In the elderly, it is well known that the skeletal system undergoes significant changes both quantitatively and morphologically. Age-related bone loss causes the common pathological condition, osteoporosis, which increases the risk of fractures in the elderly. Oral exostosis is another pathology of bone that is common in the elderly, but it is characterized by excessive bone formation. Oral exostosis is one of the frequent obstacles to the creation and wearing of artificial dentures. Oral exostoses should be removed, if they are too large. Exostosis generally exists as a smooth and round bony protuberance, which varies in size and number. It is classified as mandibular, palatal, and maxillary tori by its location. Mandibular tori occur chiefly in the premolar region of the lingual aspect of the mandible. Palatal tori appear along the midline of the hard palate. Maxillary tori are located mostly in the molar region of the buccal aspect of the maxillae. A large number of investigators have so far illustrated the influence of genetic and environmental factors, including nutritional, behavioral, and occlusal stress,[1] but the biological and morphological significance of exostosis is still unclear. We are interested in the findings that these two opposite phenomena, bone loss and excessive bone formation, occur in the elderly. We therefore examined the relationship between oral exostosis and skeletal bone mineral density (BMD) in the elderly.

Subjects and methods

We recruited, randomly, female patients who visited the Department of Dentistry and Oral Surgery, Tokyo metropolitan Geriatric Medical Center. These patients were recommended to and agreed to visit the osteoporosis clinic at this center. Exclusion criteria included hypothyroidism, neoplasm of bone and blood, renal insufficiency, gastric resection, and diseases that may cause deterioration in daily activities, such as Parkinson's disease. All subjects were examined for exostoses by two expert oral surgeons. The existence of exostosis was evaluated on visual inspection and with digital examination. Study models were made for records and to help with the digital examination. The BMDs of the femur and radius were measured by dual-energy X-ray absorptiometry (DXA; DPX-L IQ; Lunar, Madison, WI, USA). A total scan was used for

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the proximal femur, and a shaft scan (33%) was used for the radius. The Z score (which is the deviation from the weight-adjusted average BMD of each age) was calculated by the software installed in the Lunar DPX-L, based on 20000 Japanese women's data. This score was used to cancel the effects of body size and age on BMD. Values for results were expressed as means ± SEM. Differences of BMD Z scores between the group with oral exostoses (palatal, mandibular, or maxillary tori) and the group without any exostosis were examined statistically, using Student's *t*-text (unpaired, two-sided test). The data analysis was performed using StatView software (SAS, Cary, NC, USA). A *P* value of less than 0.05 was considered statistically significant.

Results

Forty-four female patients (aged 57 to 98 years; average, 74.0 ± 1.2 years) matched our criteria. Fifteen subjects (34.1%) had palatal tori, 15 (34.1%) had mandibular tori, 13 (29.5%) had maxillary tori, and 16 (36.4%) had no exostosis (controls). Several subjects had two or more tori. There was no association between the existence of oral exostoses and body mass index (BMI) (Table 1). The subjects with palatal tori ($n = 15$) had a higher femoral BMD (Z score) than controls ($n = 14$) (0.580 ± 0.213 vs −0.271 ± 0.182; $P = 0.0054$). The subjects with palatal tori ($n = 12$) also had a higher BMD (Z score) than controls ($n = 12$) at the radius (0.417 ± 0.235 vs −0.533 +0.294; $P = 0.0194$). In addition, the subjects with mandibular tori ($n = 13$) had a higher femoral BMD (Z score) than controls ($n = 14$) (0.569 ± 0.242 vs −0.271 ± 0.182; $P = 0.0097$). On the other hand, the effects of mandibular tori on the radius BMD (Z score) and the effects of maxillary tori on the femoral and radius BMD (Z score) were not statistically significant, although the difference between the groups appeared to show the same trend of higher BMD for those with tori (Table 2). Bone mineral content (BMC) was not different among the groups in this study (data not shown).

Discussion

It has been reported that environmental factors could induce mandibular tori. Mechanical stress such as occlusal force may be a factor leading to mandibular tori.[2] On the other hand, it has been suggested that genetic factors play a major role in the development of palatal tori, rather than environmental factors.[3] In the present study, there was a significant positive correlation between the presence of palatal tori and BMD at the femur and radius. In addition, an identical correlation was detected between the presence of mandibular tori and femoral BMD. We did not include the lumbar spine measurement of BMD in the present study because the high prevalence of spinal deformity due to compression fractures or osteoarthrosis in elderly people would confuse the data analysis. Our results confirmed the previous observation by Hjertstedt et al.[4] On the other hand, we could not find a significant correlation between mandibular tori and BMD at the radius or between the presence of maxillary tori and BMD at the femur and radius. These results suggest that some common mecha-

Table 1. Background data of the subjects

Groups	Palatal tori	Mandibular tori	Maxillary tori	Without exostosis	All subjects
Number of subjects	15	15	13	16	44
Age (years; mean ± SE)	70.2 ± 1.1	71.6 ± 1.2	76.6 ± 2.6	74.5 ± 2.2	74.0 ± 1.2
Height (cm; mean ± SE)	149.5 ± 1.7	149.9 ± 1.7	149.6 ± 1.5	148.3 ± 1.2	149.1 ± 0.9
Weight (kg; mean ± SE)	51.1 ± 3.1	51.2 ± 3.5	53.4 ± 3.1	48.5 ± 2.1	49.7 ± 1.4
BMI (mean ± SE)	23.2 ± 0.9	22.7 ± 1.2	22.5 ± 0.9	21.5 ± 0.8	22.3 ± 0.6

Some subjects had two or more tori
BMI, body mass index

Table 2. Correlation between exostoses and BMD

	Palatal tori		Mandibular tori		Maxillary tori		Without exostosis
BMD site	Z score	*P* value	Z score	*P* value	Z score	*P* value	Z score
Femur	0.580 ± 0.213	0.0054*	0.569 ± 0.242	0.0097*	0.317 ± 0.275	0.0798	−0.271 ± 0.182
Radius	0.417 ± 0.235	0.0194*	0.175 ± 0.124	0.0766	0.250 ± 0.245	0.0745	−0.533 ± 0.294

* *P* values less than 0.05 compared with controls
Data values are means ± SE
BMD, bone mineral density

nisms are involved in the elevation of skeletal BMD and the occurrence of oral exostoses, but the effect varies according to the sites of tori. Although a total body scan was not performed, whole-body BMD data would be helpful to consider whether the oral exotoses would affect systemic BMD or whether the effects would be site-specific.

Mechanical loading is known to be important to attain and keep bone mineral density.[5] The femur is a weight-bearing bone, whereas the radius is a non-weight-bearing bone. From the results presented here, we speculate that the sensitivity of bone for mechanical-stress-induced bone gain may be determined genetically, and this genetic trait is highlighted at specific sites in the skeletal system, i.e., weight-bearing bones.

Recently, it was reported that a point mutation in the low-density lipoprotein (LDL)-receptor-related protein 5 (*LRP5*) gene caused high bone density, and all of the affected subjects had palatal tori.[6] This mutation prevents the antagonistic effects of Dickkopf on *LRP5* and is assumed to augment the Wingless (Wnt) signal toward bone formation. On the other hand, loss-of-function type mutations in the *LRP5* gene were reported to cause the autosomal recessive disorder osteoporosis-pseudoglioma syndrome.[7] Our results presented here in this report showed the association of higher BMD with palatal tori in unrelated general population subjects, suggesting the pivotal roles of *LRP5* and related genes in both phenomena. Elucidation of the interplay of genetic factors, including *LRP5* gene polymorphisms, and mechanical stress would provide us with a novel way to prevent and treat osteoporosis.

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