Determination of longitudinal changes in the mandibular alveolar ridge of edentulous patients by comparing the position of the mental foramen in panoramic radiographs

Takahiro Koizumi, Kazutoshi Kakimoto, Tamao Tanaka, Akihiro Ueda, Eigo Utoh, Yu-fen Qian' and Yutaka Komasa

Department of Geriatric Dentistry, Osaka Dental University 8-1 Kuzuhahanazono-cho, Hirakata-shi, Osaka 573-1121, Japan
' Department of Orthodontics College of Stomatology, Ninth People’s Hospital School of Medicine, Shanghai Jiao Tong University, 639 Zhi Zao Ju Road, Shanghai 200011, P.R. China

We studied longitudinal changes in the mandibular alveolar ridges of edentulous patients by comparing the relative position of the mental foramen over time in panoramic radiographs of patients visiting Osaka Dental University Hospital. We examined the panoramic radiographs of 73 patients (25 males and 48 females) with edentulous mandibles, who had full dentures fabricated two or more times from 1976 to 2003. The average age at initial examination was 66 years. During the investigation period, the mandibular full dentures were fabricated twice for 68 subjects and 3 times for 5 subjects. The interval between fabrications ranged from 1 to 17 years with an average of 5.4 years.

Regression analysis showed that the mandible of the edentulous patients resorbed over time. We found that the length of time wearing the denture had a greater influence on resorption of the alveolar ridge than age, gender or side (left or right). Although wearing a full denture promoted resorption of the mandible, the resorption was less in patients who had been using the full denture for a long time. (J Osaka Dent Univ 2009; 43: 169–173)

Key words: Jaw; Edentulous; Panoramic radiography; Longitudinal change

INTRODUCTION

It has been reported that the height of the edentulous alveolar ridge decreases over time by gradual resorption.1-6 Numerous researchers have used panoramic radiographs to investigate resorption of the alveolar ridge.7-11 The distance from the lower border of the mandible to the mental foramen serves as an anatomical index on panoramic radiographs that scarcely changes over time.12,13 As a result, resorption of the alveolar ridge raises the relative position of the mental foramen in the body of the mandible.14 Therefore, the position of the mental foramen can be used as an index of alveolar ridge resorption.7,15 The resorption of the mandible with age has been examined by comparing the relative position of the mental foramen to the height of the mandible.1 However, comparing radiographs of different edentulous patients might not accurately show longitudinal changes in the mandible. In this respect, evaluation of the longitudinal changes for each edentulous patient might indicate resorption of the alveolar ridge more clearly.

MATERIALS AND METHODS

Materials

We examined panoramic radiographs of patients with edentulous mandibles, who had full dentures fabricated two or more times from 1976 to 2003 at Osaka Dental University Hospital. In addition, we examined panoramic radiographs where the mental foramen on one side was clear in 151 patients who did not have a malignant tumor or a disease that affected the cortical bone. A total of 73 patients, including 25 males and 48 females, were examined. The average age at the initial examination for fabri-
cation of a mandibular full denture was 66 years. During the investigation period, 68 patients had the mandibular full denture fabricated twice and 5 had it made three times. The average fabrication interval was 5.4 years (range 1–17 years).

The study protocol was approved by the Osaka Dental University Ethics Committee (No. 050928), and this research was based on the ethics guidelines for epidemiological research of the Ministry of Education, Science and Technology, and the Ministry of Labor and Welfare.

Methods
Vertical position ratio of the mental foramen
We measured the vertical position ratio of the mental foramen, which has very little distortion on panoramic radiographs. Also, the ratio does not change on different panoramic X-ray machines. The distance from the intersection of the long axis and the short axis of the mental foramen (the center point of the mental foramen) to the tangent on the lower border of the mandible was assumed to be "a", as shown in Fig. 1. In addition, the distance to the upper border of the mandible on the perpendicular line drawn from the tangent on the lower edge of the mandible towards the center point of the mental foramen was assumed to be "b".

Each panoramic radiograph was placed on an X-ray viewer, and the distances "a" and "b" were measured to 0.1 mm with calipers. The relative vertical position of the mental foramen \( (Rm) \) was defined as \( Rm = a/b \).

Longitudinal changes in the vertical position ratio of the mental foramen
Longitudinal changes in the vertical position of the mental foramen position \( (\Delta Rm) \) were calculated over time in each patient using the formula \( \Delta Rm = Rmi - Rm \), where \( Rmi \) is the value at the initial examination. Resorption of the mandible usually progresses from the upper border of the alveolar ridge. Therefore, the value of "b" will decrease although "a" will not change significantly, even with resorption of the alveolar ridge. Consequently, the vertical position ratio of the mental foramen, \( Rm \), will increase. We investigated how the difference in the vertical position ratio of the mental foramen changes over time, and compared the values at the initial examination with those of the second and third examinations in patients when they had their full denture remade.

RESULTS
Scatter plots in Fig. 2 show the relation between age and the vertical position ratio of the mental foramen. The regression equation by linear regression was \( Rm = 0.0033 \times A + 0.3924 \) on the right side and \( Rm = 0.0010 \times A + 0.5355 \) on the left side where \( A \) is the age. ANOVA revealed that the re-
Longitudinal changes in the mandibular alveolar ridge

Fig. 2 Relation between age and the vertical position ratio of the mental foramen (Rm).

Fig. 3 Relation between the time since the most recent denture fabrication and changes in the vertical position ratio of the mental foramen (ΔRm).

currence was significant at the 5% level on the right side whereas it was not on the left side. Regression analysis was not very productive because the coefficient of determination (R²) was 0.08 on the right side and 0.01 on the left. On the right side, the vertical position ratio of the mental foramen increased with age, and resorption of the alveolar ridge was confirmed. Because there were panoramic radiographs in which the mental foramen could not be distinguished, fewer specimens were observed on the left side (n=71) than on the right (n=73).

When examining the relation between age and the vertical position ratio of the mental foramen according to gender, the regression equation for males was \( Rm = 0.0050 \times A + 0.2622 \) on the right side and \( Rm = 0.0014 \times A + 0.4893 \) on the left. That for females was \( Rm = 0.0025 \times A + 0.4461 \) on the right and \( Rm = 0.0009 \times A + 0.5470 \) on the left. Recurrences on both sides were not significant at the 5% level in both males and females. Moreover, the regression coefficient for both sides in males was greater than that in females, and this tendency was
especially marked on the right side.

Scatter plots in Fig. 3 show how changes in the vertical position ratio of the mental foramen varies depending on how many years it has been since the most recent full denture was fabricated. When the Y intercept was assumed to be 0, the regression equation was $\Delta Rm=0.0040 \times T$ on the right side and $\Delta Rm=0.0045 \times T + 0.5355$ on the left side, where $T$ is the number of years since fabrication. The recurrence was significant at the 1% level when analyzed with ANOVA. The application of the regression was good because the coefficient of determination ($R^2$) was 0.57 on the right and 0.62 on the left. This suggests that the vertical position ratio of the mental foramen increased over time, confirming resorption of the alveolar ridge. When the relation between age and the vertical position ratio of the mental foramen was separated out by gender, the regression equation for males was $\Delta Rm=0.0043 \times T$ on the right side and $\Delta Rm=0.0043 \times T$ on the left, while that for the females was $\Delta Rm=0.0039 \times T$ on the right and $\Delta Rm=0.0047 \times T$ on the left. The recurrences on both sides were significant at the 1% level in both genders.

Differences between the left and right sides in the vertical position ratio of the mental foramen over time are shown in Fig. 4. There were few differences in the vertical position ratio of the mental foramen at 11 years or more when compared with the period 6–10 years. However, there was considerable difference between the period 6–10 years and that of 1–5 years.

**DISCUSSION**

**Radiographs**

The panoramic radiographs used in this study were not standardized; variations in the model or settings of the panorama X-ray machine and distortion of radiographs could have influenced the results. More accurate data would require a greater degree of standardization of the panoramic radiographs. However, it may not be possible to collect standardized data with high accuracy from all patients. We think the results are reliable because the investigation used a large number of panoramic radiographs. Moreover, this research used a relative ratio at the center of the mental foramen in the mandible as the index. In addition, we only used panoramic radiographs of patients who were free of disease affecting the cortical bone, and in whom the mental foramen on one side could be clearly identified.

**Longitudinal changes in the vertical position ratio of the mental foramen**

Regression analysis showed that the relative position of the mental foramen moved upwards (Fig. 2). Similar results reported by a recent study confirmed longitudinal resorption of the alveolar ridge in patients with edentulous mandibles. Moreover, it was shown that the longitudinal resorption of the right side was greater than that of the left because the regression coefficient of the right side was greater than the left. This could be explained by masticatory force and the habitual masticatory side. The regression coefficient indicated that longitudinal changes in the mandibles of males were greater than in females. The right regression coefficient in females was twice or more that of the left (Fig. 2). Our study confirmed a recent investigation that reported similar findings. Masticatory force may explain these differences, as well as differences between the right and left sides.

There are also gender differences in the remod-
eling of the cancellous bone.\textsuperscript{16, 17} For instance, although the width of bone trabecula decreases with aging in males, the number of trabecula decreases in the females.\textsuperscript{18} While the area of the bone surface covered with resorption lacunae increases in females, it does not increase in males.\textsuperscript{19} Although the functional activity of osteoblasts on the surface of osteoid decreases remarkably in males with aging, it remains constant in females.\textsuperscript{18} The average thickness of bone trabecula in males less than 60 years of age is significantly greater than in females. However, this thickness decreases with aging by 30%.\textsuperscript{16} These factors could be responsible for the gender difference in bone resorption.

On the other hand, the regression coefficient based on the length of time the denture was worn (Fig. 3) was larger than the regression coefficient based on age (Fig. 2). In addition, coefficients of determination were also large. Therefore, it seems that wearing a full denture promotes resorption of the alveolar ridge with age. Moreover, no differences could be confirmed over time between the left and right sides, or between the genders. These findings suggest that wearing dentures influences resorption of the alveolar ridge more than gender or side differences.

As a result, the difference of the vertical position ratio of the mental foramen for the period 6 to 10 years was almost the same as that for the period of 11 years or more, even though that for 6 to 10 years was greater than for 1 to 5 years (Fig. 3). It is thought that resorption of the mandible does not progress much in patients who have been using dentures for a long time. This may indicate that mandibular resorption is greater when the denture is fabricated more often, which may occur when the fit is bad. However, a more detailed investigation is required because some patients with a long interval between denture fabrications might have received denture treatment during the observation period at a dental office other than our hospital.

REFERENCES


