Radiographic study of bone loss of mandibular lingual cortical plate accompanied by third molar development

Minoru Yamaoka, DDS, PhD,[a] Kiyofumi Furusawa, DDS, PhD,[b] Masaya Yamamoto, DDS, PhD,[c] Hitoshi Tanaka, DDS,[c] and Fumitsugu Horiguchi, DDS,[c] Shiojiri, Nagano, Japan
ORAL AND MAXILLOFACIAL SURGERY DEPARTMENT II, MATSUMOTO DENTAL COLLEGE

Objective. The purpose was to determine the features of mandibular lingual cortical bone loss around the root of the mandibular third molar.
Study design. We examined occlusal radiographs in 2210 persons aged 11 to 78 years.
Results. Prominent increase of incidence of bone loss was evident in subjects in their third decade compared with those in their second decade. The incidence was not decreased into the sixties. The incidence of bone loss in men was significantly higher than that in women. The incidence was not influenced by inflammation around the tooth crown of the third molar, by tooth caries, or by metal fillings present in the third molar.
Conclusions. The present observations suggest that bone loss is induced by physiologic processes that accompany root formation of the third molar after mandibular growth.
(ORAL SURG ORAL MED ORAL PATHOL ORAL RADIOL ENDOD 1995;80;650-4)

The features associated with impacted third molars include a shorter, narrower, more acutely angled mandible and a reduced amount of mandibular growth.[1] Pre-eruptive movements of the mandibular third molar were demonstrated by Richardson.[2] In the absence of sufficient space, uprighting movements of the mandibular third molar may result in mesioangular impaction.[2]

The root apices of horizontal mandibular third molars are sometimes located near the lingual cortical plate, and because the mandibular lingual plate is thin, it can break as a result of strain during third molar removal. In excessive thinning of the cortical plate, loss of the bone connected with the root of the third molar is visible on radiographs, and therefore the cortical bone normally present between the periodontium and periosteum seems to be resorbed at the thinnest point. Indeed, displacement of a tooth or root into the subperiosteal space through lingual cortical bone loss can occur during third molar removal, resulting in lingual anesthesia caused by laceration of the lingual nerve. Lingual cortical bone loss is observed even if there are no signs of inflammation of the third molar and its adjacent tissue.

The lingual mandibular bone concavity is a radiographic bony entity. The origin of the entity and the histologic features of the contents within the concavity are probably related to the size and growth of the structures located in the submandibular space and the contiguous areas.[3] Connor[4] reported a lingual mandibular bone concavity in the canine region, which has no subperiosteal contents. However, there is little information available in the literature with respect to bone loss in the mandibular lingual cortical plate at the third molar. The purposes of this study were to determine the prevalence of bone loss in the mandibular lingual cortical plate at the third molar according to age and gender and to assess the effects of inflammation, tooth caries, and metal fillings on bone loss and the effects of tooth development on cortical bone loss.

METHODS

Between 1984 and 1994 a total of 2210 healthy out patients, ranging in age from 11 to 78 years (average age, 27.2 years), were referred to our hospital for consultation and treatment including preventive or therapeutic removal of mandibular third molar, salivary calculus, and orthodontic treatment. In these patients, occlusal radiographs of the mandibular molar region were obtained with a lateral cross-sectional mandibular occlusal projection with an x-ray machine (Morita, Tokyo, or Asahi, Kyoto) and occlusal film (Eastman Kodak, Rochester, N.Y.) at 60 or 70 KVp for 0.7 or 0.4 seconds. Radiographs covering the buccal and lingual cortical plates of half of the mandible were selected in this study. The bone loss of the mandibular lingual cortical plate adjacent to the root

[a]Professor and Chairman.
[b]Assistant Professor.
[c]Staff member.
Received for publication Mar. 10, 1995; returned for revision Apr. 24, 1995; accepted for publication June 14, 1995.

1079-2104/95/$5.00 + 0 **7/12/67175**

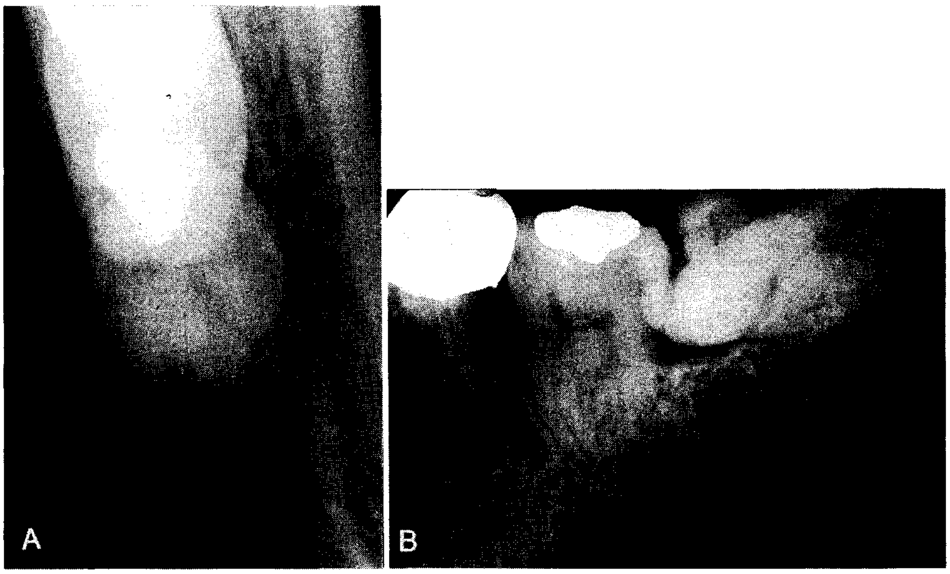

Fig. 1. **A**, Radiographic image of bone loss seen in lingual cortical plate at lateral side of root of mandibular third molar in 37-year-old female. Note bone loss and thin cortex at concavity from mandibular body to ramus. **B,** Dental film of same subject shows degrees of impaction and angulation of third molar seen in many of the subjects.

Table I. Prevalence of bone loss

	Age groups (years)															
	11 ~ 20		*21 ~ 30*		*31 ~ 40*		*41 ~ 50*		*51 ~ 60*		*61 ~ 70*		*70 ≦*		*Total*	
	Male	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*
Number of teeth	223	522	559	721	212	245	105	82	50	41	15	13	5	4	1169	1628
Number of bone loss	2	0	26	18	14	12	4	5	1	1	3	1	0	0	50	37
Percentage	0.90	0	4.65	2.50	6.60	4.89	3.80	6.09	2.00	2.43	20	7.69	0	0	4.27	2.27

*$p < 0.05$
†$p < 0.01$

apex or lateral side of the root but not radiolucency around the tooth crown was retrospectively evaluated by examining a total of 2797 radiographs. These radiographs showed the entire mandibular third molar and adjacent lingual cortical bone surface even if there was a relative lack of space between the second molar and the anterior border of the ramus; they clearly showed the root apex of the mandibular third molar even if the position was erupted, impacted, horizontal, or mesioangular and even if root development was complete or incomplete. Of the 2210 patients, 630 (28.5%) had received more than one occlusal radiographic examination for follow-up observation, and the radiographs obtained at the initial examination were used for assessment. The prevalence of bone loss according to age and gender and the relationship of bone loss to inflammation and the condition of the tooth were studied.

Statistical analysis

The significance of differences between mean values for each pair of groups according to age, gender, inflammation, and findings for the tooth crown was assessed by chi-square, Student's *t* test or Welch's *t* test.

RESULTS

All teeth examined were at approximately the same level as or above the root apex of the mandibular second molar even if impaction was present.

The prevalence of bone loss in the mandibular lin-

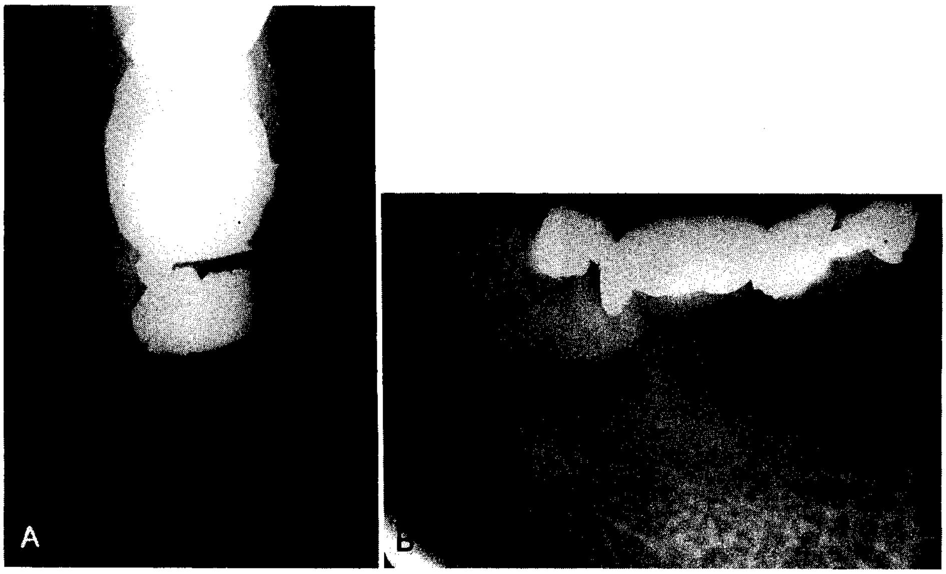

Fig. 2. **A,** Root apex protrudes onto bone probably as a result of bone destruction in 24-year-old male. **B,** Dental film of same subject shows degrees of impaction and angulation of third molar seen in many of the subjects.

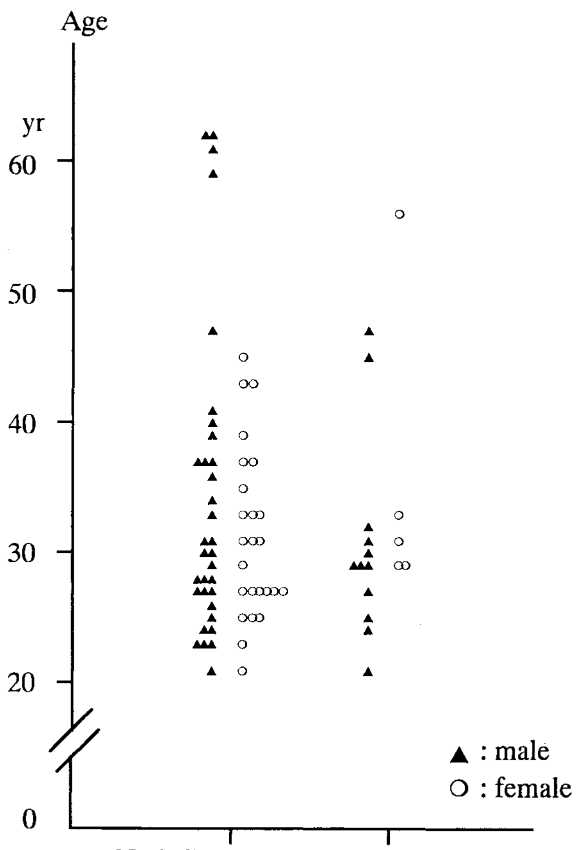

Fig. 3. Relationship between age and status of inflammation around tooth crown of third molar in males and females. Presence or absence of inflammation was assessed for each tooth rather than for each patient. Twelve teeth were excluded because inflammation status could not be identified.

gual cortical plate with the presence of the root apex or lateral side of the root of the third molar was 3.11% (87 of 2797 third molars in 83 of the 2210 persons). The anamnesis of the 83 subjects with bone loss was unremarkable in 76 but included a history of hepatitis in two patients and a history of pancreatitis, inguinal hernia, meningitis, ovarian tumor, and rheumatism in one patient each.

The prevalence of the bone loss by age decade and gender group is shown in Table I. Bone loss was not observed in males aged 19 years or below or 63 years or above or in females 20 years or below or 68 years or above. There was a significant difference between the incidence of bone loss in the subjects aged 11 to 20 years (males, 2 of 223; females, 0 of 522) and that in those aged 21 to 30 years (males, 26 of 559; females, 18 of 721) in both males ($p < 0.05$) and females ($p < 0.01$). Thus, the proportion with bone loss was low in the subjects 11 to 20 years of age but was markedly increased in those 21 to 30 years old. There was no significant difference in bone loss between the subjects aged 21 to 30 years and those aged 31 to 40 years. However, the incidence of bone loss in all of the males (50 of 1169) was significantly higher than that in all of the females (37 of 1628) ($p < 0.01$). And there was a significant difference between the incidence of bone loss in the males aged 21 to 30 years (26 of 559) and that in females in the same age group (18 of 721) ($p < 0.05$).

A smooth area of transition to healthy bone was seen in 84 of the 87 teeth with bone loss (Fig. 1), whereas protrusion onto the cortical plate was seen in three. One of the latter teeth showed torus-like swell-

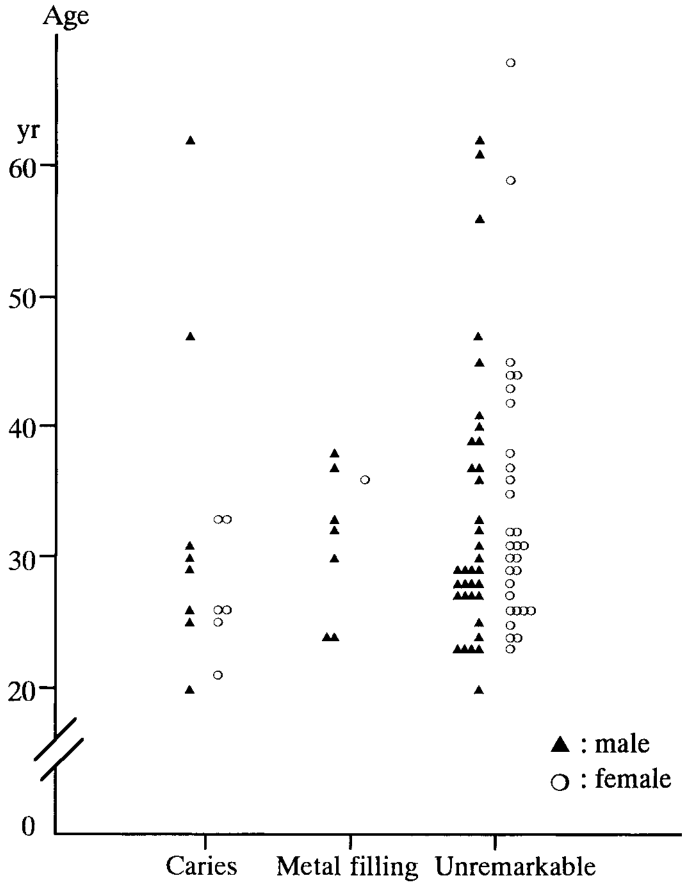

Fig. 4. Relationship between findings for tooth crown of mandibular third molar and age in males and females. *Unremarkable* indicates radiographically tooth crowns that could not be determined to be healthy.

ing without any symptoms. The other two teeth presented bone destruction associated with inflammation around the root. The root in a patient with peritonsillitis based on periodontitis in the root apex is shown in Fig. 2.

No significant difference in the incidence of inflammation around the tooth crown of the mandibular third molar was seen in either gender (Fig. 3). When the subjects were classified into three groups according to the radiographic state of the tooth crown on the basis of tooth caries, metal filling, or unremarkable crown, no gender differences among the three groups were detected (Fig. 4).

None of the 630 patients who underwent follow-up radiography showed any further bone loss.

DISCUSSION

Bone loss together with disappearance of the lamina dura was seen in the mandibular lingual cortical bone at the third molar in 3.1% of our healthy subjects. Systemic disease did not seem to be related to the bone loss in this region except in one patient with rheumatism. However, it is unknown whether a history of rheumatism is related specifically with the mandibular lingual cortical bone loss, although it is known that rheumatism destroys articular processes.

A prominent increase in the frequency of bone loss was seen in subjects in their twenties. The rarity of bone loss before adulthood could be a clue in the understanding of this process. During growth of the posterior mandibular body, bone formation is seen on the buccal side, and bone resorption combined with endosteal bone formation is seen on the lingual side.[5] The "buccal drift" of the mandible stops in association with skeletal maturity. However, the root of the mandibular third molar is completed at the age of 23 ± 4 years.[6] Marked changes, occurring late in the tooth development, would make a major contribution to the bone loss. Moreover, with respect to the direction of root development, disturbance of tooth eruption produced by the ascending branch and by the second molar might lead to posterior root development into the lingual cortical wall between the mandibular body and lateral extension of the ramus resulting in direct contact of the third molar root with the cortical bone and periosteum and considerable thinning of cortical bone or bone loss. This pattern caused by both reduced bone formation and increased root formation may be a specific local change and an age-related change, although it may be modified by gender as shown by the higher incidence in males. Furthermore, as bone formation can be reduced by disuse,[7] one of the causes of bone loss may be the absence of the mechanical loading of occlusion or mastication if the mandibular third molar shows horizontal impaction.

These observations suggest that bone turnover is sensitive to tooth development. The relative balance between bone resorption and formation through the growth and differentiation of mesenchymal cells may serve to maintain a minimally adequate structure during the period from the twenties to the sixties. Recently feedback theory was applied to homeostatic control of bone structure,[8] and such a system may provide continuous control of the state of mandibular bone loss. When bone loss is histologically identified with coherence between the periodontium and periosteum, it is possible that these structures conserve the tooth in response to its protrusion as a result of root growth or bone resorption. The significantly increased incidence of bone loss that we observed in males in their sixties suggests that absolute bone mass or cortical bone mass decreases with age.

Inflammation may influence the balance and feedback system between bone formation and resorption, and the bone may lose its capacity to adapt to change, resulting in structural alteration. However, the bone loss we observed did not appear to be related to the presence or absence of pericoronitis, tooth caries, or a metal filling but was affected by the periodontitis at the root apex. The periodontium is well known as a good site for measurement of the effects of inflammation.

Protrusion onto the cortical plate was seen in three teeth. The periodontium or periosteum may be activated by contact with each other in the prevention of root "eruption." The surface and envelope of the periosteum gain bone, whereas those of the trabeculum and cortical-endosteum lose bone.[9] Root protrusion onto the bone surface as a result of destruction of the periodontium indicates the importance of the periodontium in tooth death caused by tooth caries. The periodontium may have a major direct effect on bone metabolism, may contribute to bone formation, or may have an indirect effect through signals from receptors in the periodontium. This hypothesis of the effect of the periodontium is also supported by the observation that bone transplanted from the iliac crest to the alveolar cleft remains in good condition without resorption when a tooth is transferred into the transplanted bone by orthodontic treatment, whereas bone resorption is detectable when no tooth is present. Although root development in the lingual or distal direction seems to produce root protrusion onto the bone, it unquestionably provides an opportunity for physiologic development of both tooth and bone. The mechanism sustaining this process of action of bone formation and resorption is unclear. Comprehension of the process would be important into determine the nature of various phenomena that may occur in periodontitis and orthodontic movements and the role of the periodontium in cessation of tooth eruption. This condition should also be differentiated from odontogenic infections and malignant tumors, and the removal of impacted third molar should be cautioned against.

In conclusion, mandibular lingual cortical bone loss around the root of the mandibular third molar may arise as a result of the third molar development in association with mandibular growth and may be sustained through old age.

We thank Miss Satomi Motoki for typing services.

REFERENCES

1. Richardson ME. The etiology and prediction of mandibular third molar impaction. Angle Orthod 1977;47:165-72.
2. Richardson M. Pre-eruptive movements of the mandibular third molar. Angle Orthod 1978;48:187-93.
3. Mainous EG, Boyne PJ. Lingual mandibular bone concavity. J Am Dent Assoc 1975;90:666-8.
4. Connor MS. Anterior lingual mandibular bone concavity: report of a case. ORAL SURG ORAL MED ORAL PATHOL 1979; 48:413-4.
5. Enlow DH, Harris DB. A study of the postnatal growth of the human mandible. Am J Orthodont 1964;50:25-50.
6. Köhler S, Schmelzle R, Loitz C, Puschel K. Die Eentwicklung des Weisheitszahnes als Kristerium der Lebensaltersbestimmung. Ann Anat 1994;176:339-45.
7. Minaire P, Meunier P, Edouard C, Bernard J, Courpron P, Bourret J. Quantative histological data on disuse osteoporosis. Calcif Tissue Res 1974;17:53-73.
8. Turner CH. Homeostatic control of bone structure: an application of feedback theory. Bone 1991;12:203-17.
9. Takahashi H, Frost HM. Age and sex related changes in the amount of cortex in human ribs. Acta Orthopaedica Scand 1966;37:122-30.

Reprint requests:
Minoru Yamaoka, DDS, PhD
Professor and Chairman
Oral and Maxillofacial Surgery Department II
Matsumoto Dental College
Shiojiri, Nagano 399-07 Japan