*Original Article*

# Agenesis of Third Molar Germs Depends on Sagittal Maxillary Jaw Dimensions in Orthodontic Patients in Japan

**Takashi S. Kajii, DDS, PhD[a]; Yoshiaki Sato, DDS, PhD[b]; Saori Kajii, DDS[c]; Yuki Sugawara, DDS, PhD[a]; Junichiro Iida DDS, PhD[d]**

**Abstract:** The aim of this study was to determine the correlation between congenitally missing third molar tooth germs and sagittal maxillomandibular jaw dimensions in orthodontic patients in Japan. The subjects were 391 patients from the orthodontic clinic of the Hokkaido University Dental Hospital who were less than 15 years of age. Assessments were made from panoramic radiographs and lateral cephalograms. The subjects were divided into a maxillary/mandibular third molar absent and an existent group. The ANB angle and the sagittal dimensions of the nasal floor (ANS-PNS), maxillary basal bone (Mx), mandibular corpus (Go-Pog), and mandibular basal bone (Mn) were measured. Logistic regression analysis was used to estimate associations between third molar agenesis and these measures. The following results were obtained: (1) The frequency of the maxillary third molar agenesis significantly increased with decreasing Mx (odds ratio = 0.559, 95% confidence interval = 0.377 – 0.829). The frequency of the mandibular third molar agenesis also increased with decreasing Mx (odds ratio = 0.532, 95% confidence interval = 0.330 – 0.856). (2) There were no significant correlations between Mn and mandibular third molar agenesis. These results suggest that agenesis of third molar germs does not depend on anteroposterior dimensions of the mandible but depends on anteroposterior dimensions of the maxilla in Japanese orthodontic patients. (*Angle Orthod* 2004;74:337–342.)

**Key Words:** Third molar germs; Congenital absence; Maxilla; Mandible; Posterior discrepancy



## INTRODUCTION

There have been many reports that describe the congenital absence of third molars in European American,[1–7] and Asian[8–11] patients. In Japan, many investigators and clinicians, especially orthodontists, believe that an increase in agenesis of permanent teeth is related to degeneration of dentofacial development over the past 5000 years.[9] Is there a tendency for a higher incidence of agenesis of third molars? Unfortunately, there have been few reports on chronological changes in third molar agenesis.[12,13]

Therefore, we previously investigated[14] the congenital absence of third molar germs in Japanese orthodontic patients, and we examined the relationships between the absence of third molars and sagittal maxillomandibular jaw relationships. The following results were obtained: (1) the percentage of Japanese individuals who have congenitally missing third molars seems to have decreased slightly, (2) the frequency of the absence of mandibular third molar germs is lower than that of maxillary third molar germs in Japanese individuals, and (3) in Japanese orthodontic patients, the percentage of skeletal Class II patients with one or more third molar ageneses is lower than that of skeletal Class III patients.

On the other hand, the relationship between third molars and crowding has been debated for many years.[15–18] Merrifield[19] advocated a posterior discrepancy and suggested that orthodontists should consider the entire dentition. The relationship between a posterior discrepancy and relapse after retention has been debated[20–22] for more than 50 years. A posterior discrepancy is thought to have an inhibitory effect on the eruption of second and third molars and may cause relapse after retention regardless of whether premolars have been extracted. Space deficiency for the eruption of not only third molars but also second molars has recently been reported in Class II patients.[23,24]

Skeletal Class II patients generally have a large maxilla

[a] Assistant Professor, Section of Orthodontics, Graduate School of Dental Medicine, Hokkaido University, Sapporo, Japan.

[b] Associate Professor, Section of Orthodontics, Graduate School of Dental Medicine, Hokkaido University, Sapporo, Japan.

[c] Private Practice, Mito, Ibaragi, Japan.

[d] Professor and Chair, Section of Orthodontics, Graduate School of Dental Medicine, Hokkaido University, Sapporo, Japan.

Corresponding author: Takashi S. Kajii, Section of Orthodontics, Department of Oral Functional Science, Division of Oral Medical Science, Graduate School of Dental Medicine, Hokkaido University, Kita 13 Nishi 7 Kita-ku, Sapporo 060-8586, Hokkaido, Japan (e-mail: kajii@den.hokudai.ac.jp).

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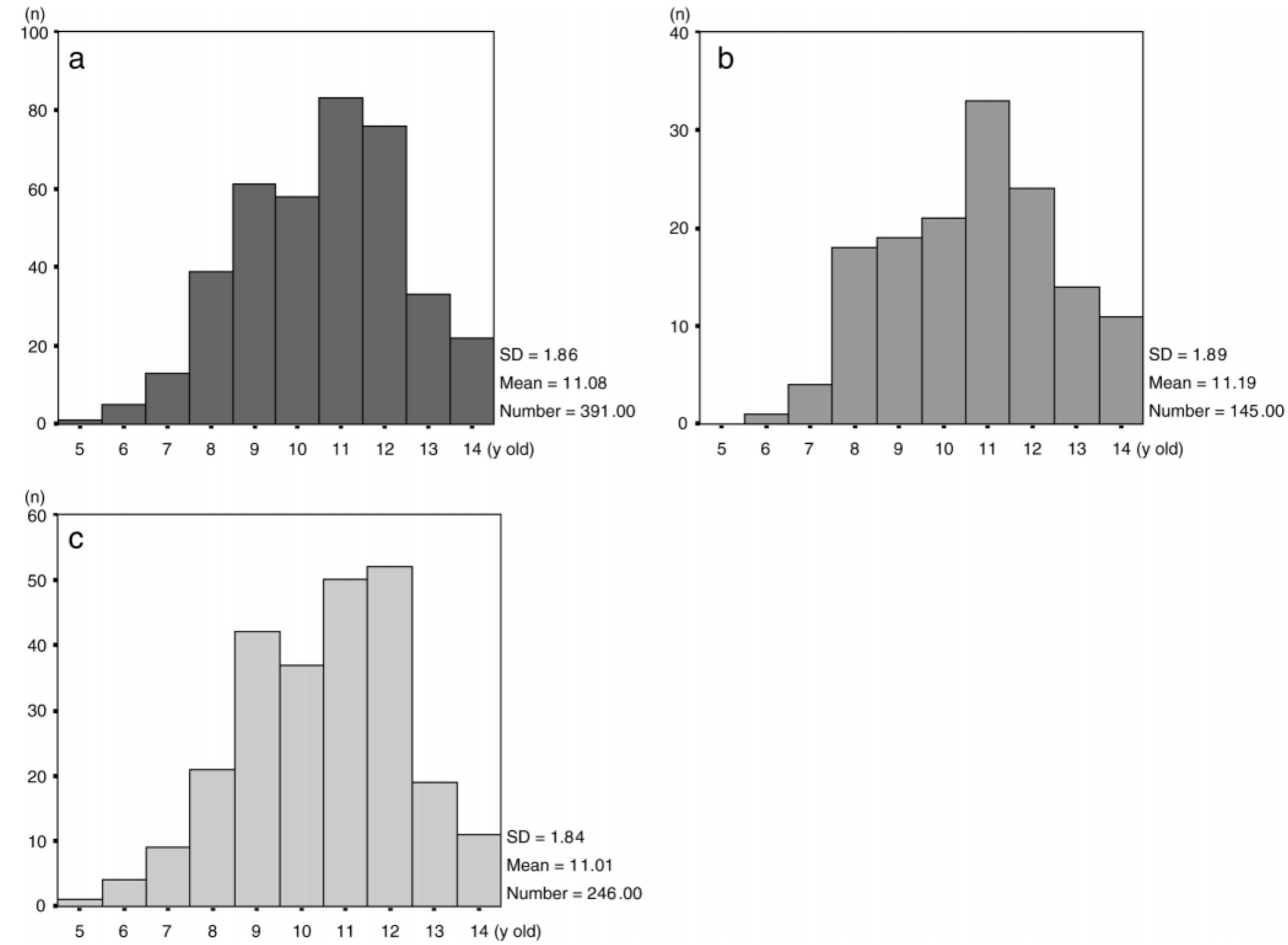


**FIGURE 1.** Distributions of ages of subjects in this study. (a) all subjects; (b) male; and (c) female.

**TABLE 1.** Subjects

| Number | Date of Birth | Age at Initial Examination |
|---|---|---|
| 391 (145 males, 246 females) | October 28, 1966 – July 20, 1987 | 5 y 7 mo – 14 y 11 mo |

and/or small mandible,[25] whereas skeletal Class III patients generally have a small maxilla and/or large mandible. The percentage of Japanese orthodontic patients with one or more third molar ageneses is lower in skeletal Class II patients than in skeletal Class III patients.[14] In addition, some reports speculate that the same genes may regulate both craniofacial and tooth morphogenesis.[8] On the basis of these facts and speculations, we hypothesize that the agenesis of maxillary third molar germs depends on anteroposterior dimensions of the maxilla when third molar formation begins, although agenesis of mandibular third molar germs does not depend on anteroposterior dimensions of the mandible. To prove this hypothesis, we investigated the correlations between agenesis of third molar germs and sagittal maxillomandibular jaw dimensions in orthodontic patients in Japan.

## MATERIALS AND METHODS

### Subjects

Three hundred ninety-one patients (145 males and 246 females) were selected for this study from the orthodontic clinic of the Hokkaido University Dental Hospital (Figure 1; Table 1). All the subjects were younger than 15 years old when they were examined initially. Subjects with congenital deformities, such as a cleft palate, were excluded from the study.

Massler et al[26] reported that third molar crypt formation begins at three to four years of age. Calcification starts at 7 to 10 years of age, and calcification of the crown is completed at 12 to16 years of age and eruption begins at 17 to 21 years of age. This means that few people younger than 15 years old would have had a third molar extracted because of dental disease such as pericoronitis. This was the reason for the selection of subjects younger than 15 years old for our study. Investigations by Garn et al[27] and Gravely[4] suggested that the upper age limit for third molar genesis is 13 years. There are some reports,[1,5,28,29] however, of third molar development as late as 14 or 15 years of age. We, therefore, examined patients up to 14 years old.

## Materials

Panoramic radiographs and lateral cephalograms taken at the initial examination were used to determine the presence of third molar germs and to measure angles and dimensions of the jaw (Figure 2). In cases where it was impossible to judge the presence of third molar germs from the panoramic radiographs taken at the initial examination, subsequent panoramic radiographs taken before the age of 14 years were used. Third molars or third molar germs refer to both impacted germs and erupted teeth.

The subjects were divided into a right and/or left maxillary third molar absent group (case n = 64) and a both-existent group (control n = 327). In the same way, the subjects were also divided into a right and/or left mandibular third molar absent group (n = 38) and a both-existent group (n = 353).

## Cephalometric analysis

The ANB angle and the anteroposterior lengths of the nasal floor (ANS-PNS), the maxillary basal bone (A-Ptm = Mx), the mandibular corpus (Go-Pog), and mandibular basal bone (ABR-B = Mn) were measured on lateral cephalograms of each subject exposed at the initial examination (Figure 2). ABR is the point where the occlusal plane crosses the anterior edge of the ramus.

## Statistical analysis

The values of these measurements depend on the age of the subjects. Therefore, these values were standardized using average values and standard deviations selected from serial records of Japanese subjects included in the files of a longitudinal craniofacial growth study at the Hokkaido University[30] or at the Osaka University Dental School.[31]

Nonadjusted and adjusted logistic regression analyses were used to estimate the associations between third molar agenesis and these cephalometric values. These analyses were carried out with the statistical package SPSS® Ver. 8.0 (SPSS Inc, Chicago, Ill), with a probability level of .05 considered statistically significant. Hosmer–Lemeshow tests were used for assessment of overall model goodness-of-fit.

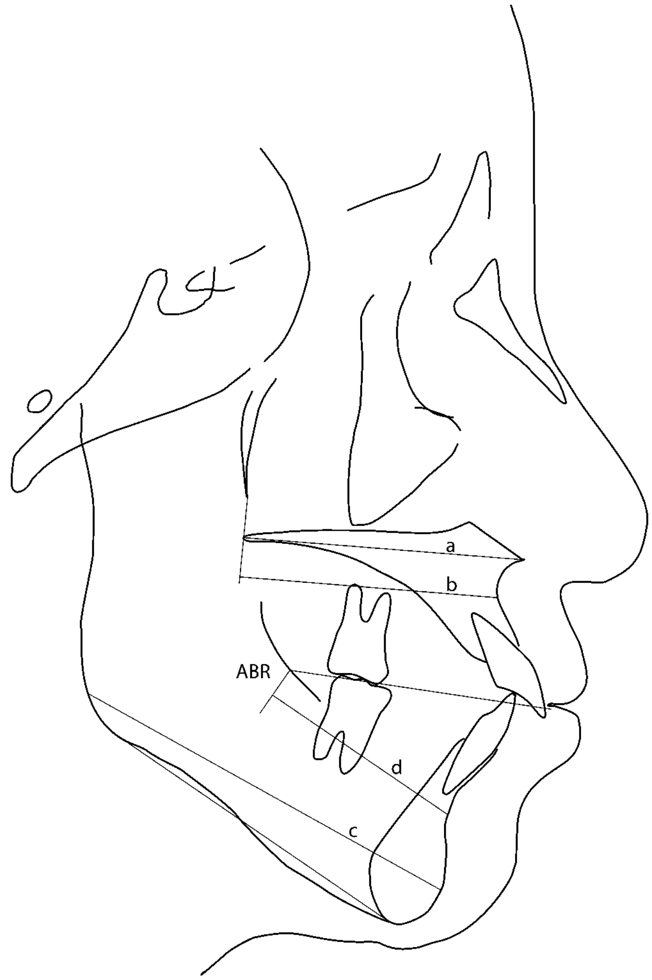


**FIGURE 2.** Linear cephalometric measurements relating to sagittal jaw dimensions. (a) ANS-PNS (mm), anteroposterior length of the nasal floor; (b) A-Ptm (Mx, mm), anteroposterior length of the maxillary basal bone; (c) Go-Pog (mm), anteroposterior length of the corpus; (d) ABR-B (Mn, mm), anteroposterior length of the mandibular basal bone (ABR: cross point between occlusal plane and anterior edge of the ramus).

**TABLE 2.** Crude Odds Ratios: Maxillary Third Molar Absent Group vs Existent Group[a]

| Variables | Odds Ratio | 95% Confidence Interval | *P* Value |
|---|---|---|---|
| Sex | 1.485 | 0.831–2.653 | .182 |
| ANB | 0.803 | 0.686–0.941 | .007** |
| ANS-PNS | 0.826 | 0.656–1.041 | .105 |
| Go-Pog | 0.896 | 0.747–1.075 | .238 |
| Mx | 0.649 | 0.508–0.828 | .005** |
| Mn | 1.135 | 0.938–1.372 | .193 |

[a] ** $P < .01$.

## RESULTS

Table 2 shows the results of the nonadjusted logistic regression analysis that estimates the associations between maxillary third molar agenesis and cephalometric measure-

**TABLE 3.** Adjusted Odds Ratios: Maxillary Third Molar Absent Group vs Existent Group[a]

| Variables | Odds Ratio | 95% Confidence Interval | *P* Value |
|---|---|---|---|
| Sex | 1.821 | 0.963–3.443 | .065 |
| ANB | 0.910 | 0.717–1.154 | .434 |
| ANS-PNS | 1.260 | 0.896–1.773 | .184 |
| Go-Pog | 0.847 | 0.672–1.068 | .160 |
| Mx | 0.559 | 0.377–0.829 | .004** |
| Mn | 1.227 | 0.947–1.588 | .121 |

[a] ** $P < .01$.

**TABLE 4.** Crude Odds Ratios: Mandibular Third Molar Absent Group vs Existent Group[a]

| Variables | Odds Ratio | 95% Confidence Interval | *P* Value |
|---|---|---|---|
| Sex | 0.792 | 0.401–1.562 | .501 |
| ANB | 0.848 | 0.698–1.031 | .098 |
| ANS-PNS | 0.871 | 0.654–1.160 | .344 |
| Go-Pog | 0.968 | 0.773–1.211 | .776 |
| Mx | 0.628 | 0.464–0.849 | .003** |
| Mn | 0.970 | 0.760–1.237 | .805 |

[a] ** $P < .01$.

ments. The numbers of subjects were 64 in the maxillary third molar absent group and 327 in the existent group. The frequency of maxillary third molar agenesis significantly increased with decreasing ANB (odds ratio = 0.803, 95% confidence interval = 0.686 – 0.941) and with decreasing Mx (odds ratio = 0.649, 95% confidence interval = 0.508 – 0.828).

After adjustment for sex, ANB, ANS-PNS, Go-Pog, Mx, and Mn, the frequency of maxillary third molar agenesis increased significantly further with a decrease in Mx (odds ratio = 0.559, 95% confidence interval = 0.377 – 0.829) (Table 3).

Table 4 shows the results of the nonadjusted logistic regression analyses that estimate the associations between mandibular third molar agenesis and cephalometric measurements. The numbers of subjects were 38 in the mandibular third molar absent group and 353 in the existent group. The frequency of mandibular third molar agenesis also increased with a decreasing Mx (odds ratio = 0.628, 95% confidence interval = 0.464 – 0.849).

Table 5 shows the results of the logistic regression analyses that estimate the associations between mandibular third molar agenesis and cephalometric measurements after adjustment for sex, ANB, ANS-PNS, Go-Pog, Mx, and Mn. The frequency of mandibular third molar agenesis increased further with decreasing Mx (odds ratio = 0.532, 95% confidence interval = 0.330 – 0.856). There were no significant associations between mandibular third molar agenesis and Mn or Go-Pog.

Hosmer–Lemeshow tests were used for assessment of overall model goodness-of-fit. Probability values were .465 (maxillary third molar model) and .665 (mandibular third molar model). Thus, these models were fitted well.

**TABLE 5.** Adjusted Odds Ratios: Mandibular Third Molar Absent Group vs Existent Group[a]

| Variables | Odds Ratio | 95% Confidence Interval | *P* Value |
|---|---|---|---|
| Sex | 0.998 | 0.482–2.065 | .996 |
| ANB | 0.938 | 0.701–1.254 | .665 |
| ANS-PNS | 1.378 | 0.898–2.115 | .143 |
| Go-Pog | 0.977 | 0.740–1.289 | .867 |
| Mx | 0.532 | 0.330–0.856 | .009** |
| Mn | 0.968 | 0.703–1.335 | .844 |

[a] ** $P < .01$.

## DISCUSSION

The frequency of maxillary third molar agenesis significantly increased with decreasing Mx (Table 3). The frequency of mandibular third molar agenesis also increased with decreasing Mx (Table 5). On the other hand, there were no significant correlations between Mn and mandibular third molar agenesis (Table 5). These results suggest that agenesis of third molar germs is not related to anteroposterior dimensions of the mandible but is related to those of the maxilla in Japanese orthodontic patients. Only a few reports[32,33] support our suggestion.

Because skeletal Class II patients generally have a large maxilla and/or small mandible[25] and skeletal Class III patients generally have a small maxilla and/or large mandible, these results also explain why the percentage of skeletal Class II patients missing one or more third molars is lower than that of skeletal Class III patients.[14] Therefore, a space deficiency for eruption of not only mandibular third molars but also mandibular second molars is often found in Class II patients.[23,24]

There have been some reports comparing the agenesis of third molars in different races. Brothwell et al[34] and Stewart[35] reported that third molar agenesis in the Mongolian population, including the Japanese population, is higher than that in the European American population. They also reported that the highest frequency of third molar germs existent is found in black subjects. We speculate that one of reasons for these racial differences is that the Mongolian population may have more skeletal Class III patients who have a small maxilla than the European American population.

There seems to be a difference in third molar agenesis in the upper and lower arches between Asians and European Americans. Specifically, mandibular third molar agenesis is lower than maxillary third molar agenesis in Asians[8–11,14] but not in European Americans.[1–7] This suggestion is supported by results reported by Hillson.[36] However, the reason why there may be a difference in third molar agenesis in the upper and lower arches between Asians and European Americans is also not clear.

The reason why a small maxilla is associated with not only maxillary third molar ageneses but also mandibular third molar agenesis is not clear. On the other hand, some reports have suggested that homeobox genes and growth factor regulate craniofacial and tooth morphogenesis. A missense mutation of the *MSX1* gene at chromosome 4p16.1 causes agenesis of second premolars and third molars in humans.[37,38] *PAX9* at chromosome 14q12-q13 is also associated with tooth agenesis,[39] especially molar agenesis.[40] Thus, some polygenetic inheritance controlling maxillary dimensions may be related to genes on formation of third molar germs.

In a future study, we will investigate the relationship between agenesis of third molar germs and some congenital deformities using cephalometric analyses. Molecular genetics of tooth morphogenesis and of craniofacial maturation should also be studied. Some polygenetic inheritance of congenital deformities may also be related to genes controlling formation of third molar germs.

## CONCLUSIONS

The frequency of maxillary third molar agenesis significantly increased with decreasing sagittal dimensions of the maxillary basal bone. The frequency of mandibular third molar agenesis also increased with decreasing sagittal dimensions of the maxillary basal bone. On the other hand, there were no significant associations between sagittal dimensions of the mandibular basal bone and mandibular third molar agenesis.

These results suggest that agenesis of third molar germs does not depend on anteroposterior dimensions of the mandible but depends on anteroposterior dimensions of the maxilla in Japanese orthodontic patients.

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