Original Article

Relationship Between Congenitally Missing Lower Third Molars and Late Formation of Tooth Germs

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Abstract: In this investigation, we used longitudinal panoramic radiographs from 96 subjects (47 boys, 49 girls) who did not have any congenital disease. The subjects were selected based on their age at the initial radiograph and the number and frequency of radiographs. Lower left premolars and second molars were used as parameters to identify factors that influence the age of formation of the third molar. We classified teeth into eight formation stages according to the method of Demirjian. The age at the beginning of formation of the lower third molar was determined with a regression equation of longitudinal data. The highest correlation existed between the age at the beginning of formation of the third molar and the formation stage of the second molar. We conclude that late formation of tooth germs is one of the factors that leads to the congenital absence of lower third molars. Furthermore, we assume that when the tooth germ of the lower third molar has not appeared at stage 7 of formation of the second molar, the probability of the third molar being missing is 100%. (*Angle Orthod* 2002;72:112–117.)

Key Words: Third molar; Congenital missing; Tooth formation

INTRODUCTION

Lower third molars are usually considered when planning orthodontic treatment. The germ of the lower third molar becomes visible on radiographs between seven and 12 years of age, which is quite a wide range.[1] Banks,[2] Saito,[3] and Levesque et al[4] all investigated the formation of third molars, and Nanda,[5] Thompson et al,[6] and Garn and Lewis[7] conducted research on the congenital absence of third molars. However, most of these studies were based on cross-sectional data and investigations of tooth germ formation and the congenital absence of lower third molars with longitudinal radiographic evaluations are scarce.

Garn et al[8] reported large differences between individuals in the shape, size, time of appearance, and formation speed of lower third molars. Some researchers have claimed that the absence of a third molar is connected to an overall congenital tendency of agenesis in an individual.[9–11] Certain congenital abnormalities have been reported to occur along with the absence of lower third molars. Bailit[12] found that the likelihood of congenitally missing other teeth was 13 times greater in individuals with a congenitally missing lower third molar. Nanda[5] and others[11,13,14] reported smaller-sized teeth and a delay in the formation phases as well.[15,16] Garn and Lewis[17] noticed that when a lower third molar was missing, the formation and eruption of premolars and molars on the same side were delayed. Keene[11] stated that missing third molars were connected with a weakness in stability of the characteristic cusp formation of molars.

The present research discusses the reasons for congenital absence of lower third molars and examines the relationship between the time of appearance of lower third molars and the formative stages of other molars and premolars.

MATERIALS AND METHODS

Ninety-six subjects (47 males and 49 females) were chosen from a total of 579 subjects with no congenital diseases (eg, cleft palate) from the files of Department of Orthodontics, Dental Hospital, Kyushu University. The requirements for choosing subjects were (1) the subject had a panoramic radiograph taken at least once every 2 years, (2) the patient had five or more panoramic radiographs taken, and (3) the initial radiograph had been taken before 10 years of age. Table 1 summarizes the age and sex distribution of the study group. The formation stage of tooth germs was evaluated from the formative condition of the crowns and roots

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TABLE 1. Age and Sex Distribution at Initial and Final Radiographic Examinations[a]

	Initial Examination		Final Examination	
	Mean ± SD	Range	Mean ± SD	Range
Male subjects	9.1 ± 1.7	6.0–12.0	16.7 ± 1.6	12.6–19.8
Female subjects	9.1 ± 1.3	6.3–11.6	16.7 ± 1.6	13.7–20.0

[a] Ages are expressed in years. The mean number of radiographs per subject was 7.4 ± 1.8 (range, 5–13).

FIGURE 1. Assessment of tooth germ formative condition (from Demirjian et al[18]).

of permanent teeth according to the method of Demirjian et al.[18] This method divides the formation of the crowns and roots of lower permanent teeth into eight stages (Figure 1). A Mann-Whitney *U*-test for sex differences in formation stage revealed no significant differences and, therefore, no sex grouping was established. Also, there were no significant differences among all teeth when a Wilcoxon rank test was applied to test for right vs left differences in formation stage. Therefore, the formation stages of the left side teeth were used in the present study.

Among the 579 reviewed cases, no tooth germ of the lower third molar appeared after 14 years of age. Subsequently, cases were divided into two groups at 14 years of age. The first group, the M group (n = 20 subjects), had a missing lower third molar at the time of birth, and the other group, the P group (n = 76 subjects), had a lower third molar present at the time of birth. This grouping resulted in 382 panoramic radiographs in the M group and 288 in the P group.

To establish the formation time of the lower third molar germ in the P group, a regression equation was established for each patient (Figure 2). If the formation stages were similar over several examinations, the earliest observation age was adopted. We considered x as the age and y as the formation stage, and we then defined the age at which $y = 1$ as the age at the beginning of formation. Based on the age at the beginning of formation, we subdivided the P group into two groups. The first group, the E group (n = 38 subjects), had early formation of the lower third molars, and the other group, the L group (n = 38 subjects), had late formation. We then compared the age at each formative stage of the tooth germ of the lower first and second premolars and the second molar between the M, E, and L groups.

Because there were not enough data for statistical analysis at stages 1, 2, and 3 of second molar formation and stages 1, 2, 3, and 4 of first and second premolar formation, we made no comparisons at these stages. The Mann-Whitney *U*-test was employed to compare formation stages among the three groups. A Spearman rank correlation was used to verify the correlation between the age at the beginning of formation of the lower third molar and the formation stages of each tooth. Statistical differences at $P < .05$, $P < .01$, and $P < .001$ were considered significant.

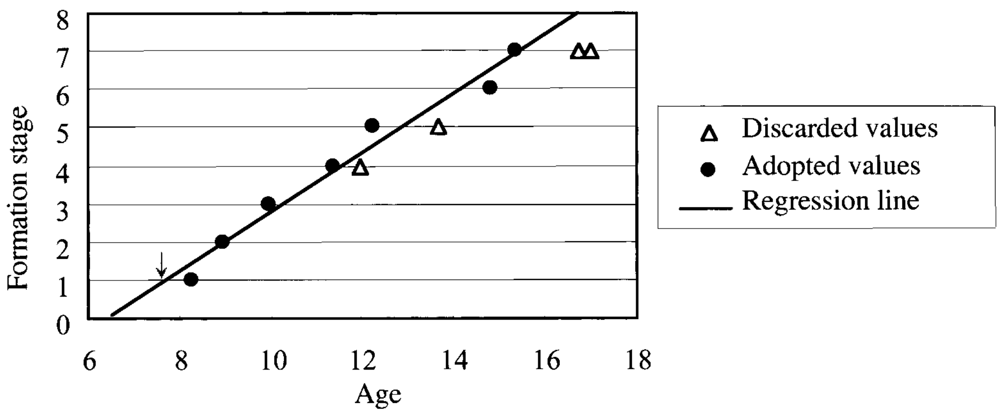

FIGURE 2. Age at the beginning of formation of the lower third molar's germ. As an example, in this case, we estimated the formation stage of the lower third molar using measurements from 11 panoramic radiographs. Of 11 values, we adopted only the dotted values to obtain the development of a personal regression line. We then estimated the subject's age at the beginning of formation to be 7.6 years (↓).

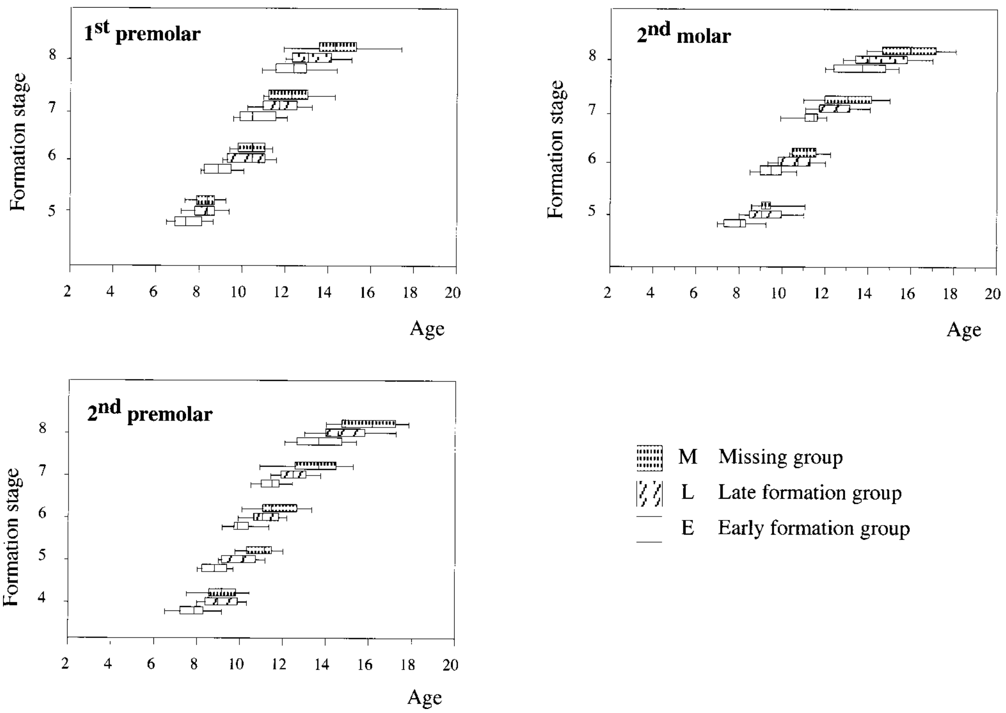

FIGURE 3. Age comparison between the three groups at each formation stage.

TABLE 2. Age at the Beginning of Formation of the Lower Third Molar [a]

	Male Subjects			Female Subjects			Male and Female Subjects		
Group	No.	Mean ± SD	Range	No.	Mean ± SD	Range	No.	Mean ± SD	Range
E	16	8.2 ± 0.7	6.9–9.3	22	8.3 ± 0.7	6.8–9.2	38	8.2 ± 0.7	6.8–9.3
L	20	10.3 ± 0.8	9.5–11.9	18	10.4 ± 0.6	9.4–11.5	38	10.4 ± 0.7	9.4–11.9
M	11	—	—	9	—	—	20	—	—

[a] E indicates early formation group; L, late formation group; and M, missing group.

RESULTS

The tooth germ of the lower third molar was confirmed in 76 out of 96 subjects, and the percentage of congenitally missing molars was therefore 20.8%. Table 2 summarizes the age at the beginning of formation of lower third molars, and Table 3 shows the ages at each formative stage.

A comparison between the ages at each formative stage among all groups is shown in Table 4 and Figure 3. The lowest age was in the E group and the highest age was in the M group for all formative stages of each tooth. The age in the M group was significantly older when compared with that of the other two groups. Thus, it is believed that the later the formation of the lower third molar, the later the formation of the other teeth. Tooth formation in group L lagged behind that in group E, and formation was slowest in group M.

The age at the beginning of formation of the lower third molar correlated with each formative stage of other teeth. The correlations for the lower second molar were higher than those for the lower premolars, and the highest correlation was at stage 4 of the second molar (Table 5).

The probability of congenitally missing third molars relative to the second molar formation stage was assessed. The probability of missing lower third molars was 53.2%, 56.6%, 80.0%, and 100% when the germ of the lower third molar had not appeared at formation stages of 4, 5, 6, and 7 or higher, respectively, of the lower second molar.

DISCUSSION

Longitudinal studies usually allow a better understanding of the processes being studied. In this study, the formation process of the subjects' teeth was depicted more precisely because of the large number of longitudinal panoramic radiographs that were available. Levesque et al[4] indicated that there were no significant differences between longitudinal and cross-sectional methods regarding the age at each formation stage. However, they did not construct personal re-

TABLE 3. Age of Subjects at Each Formation Stage [a]

Tooth		Formation Stage 0	1	2
First premolar	No. of subjects (E + L + M)	—	—	—
	Age, y			
Second premolar	No. of subjects (E + L + M)	—	—	—
	Age, y			
Second molar	No. of subjects (E + L + M)	—	—	—
	Age, y			
Third molar	No. of subjects (E + L)	31	65	46
	Age, y	8.6 ± 1.3	9.4 ± 1.4	10.8 ± 1.0

[a] Age values are expressed as mean ± SD. E indicates early formation group; L, late formation group; and M, missing group.

gression lines as we did in this investigation. To verify the methods, we determined the age at the beginning of formation of the lower third molar with both the Levesque method and our method. As a result, our method enabled us to detect the age at the beginning of formation 0.7 years earlier.

For ethical reasons, subjects cannot be exposed to ionizing radiation only for the sake of research. A panoramic radiograph was exposed yearly to evaluate the progress of treatment and, therefore, we adopted a nonparametric method in analyzing our findings.

Tanaka et al[19] reported that the time of eruption and the exchange from deciduous to permanent teeth differs between individuals and, therefore, age should not be used as a criterion to evaluate the growth condition or formation stages of a tooth. They also reported that the beginning of the lower third molar formation coincided with the completion of the root apex of the lower first molar, with the incidence of lower third molar appearance at about 76%. Accordingly, it is thought that the timing of tooth germ formation of the lower third molar can be predicted by establishing a comprehensive relationship with the formative process of other teeth. Demirjian and Levesque[20] examined the correlation of formation among teeth and subsequently divided teeth into two groups. The first group consisted of central incisors, lateral incisors, and first molars, and the second group consisted of canines, first premolars, second premolars, and second molars. However, they failed to report data for third molars.

In our results, the correlation between third molar formation and second molar formative stage was higher than that with premolar formative stage at all stages (Table 5). This finding probably reflects the fact that they belonged to the same group that is innervated by the same nerve[21] and, also, the beginning of third molar germ formation was close to formation stage 4 of the second molars (Table 3).

Bolk,[22] Fujita and Karino,[23] Fujita,[24] and Dahlberg[25] concluded that the congenital absence of teeth is a phylogenic degeneration phenomenon. Nakata[26] blamed missing teeth on genes by claiming the polygenetic theory. He further elaborated that microdontic teeth were a consequence of other missing teeth. On the other hand, Odagami et al[27] reported that tooth formation was delayed in children who had missing incisors or premolars when compared with that in healthy children and suggested that a congenitally missing tooth was related to the time of formation of other teeth. Our results agree with the results of these reports, and we suggest that the delayed formation of tooth germs that usually develop earlier than those of the lower third molar leads to the absence of lower third molars, or that there is a process that influences all of these germs simultaneously. Consequently, microdontic teeth could be a result of such delays.

Congenitally missing lower third molars were found in 20 of 96 (20.8%) of the subjects in this investigation. We believe that our results shown in Figure 3 will help in predicting the absence of lower third molars based on their relationships with lower second molars and, therefore, aid in establishing the most suitable orthodontic treatment plan.

CONCLUSIONS

We draw the following conclusions from this research:

1. There is a correlation between the age at the beginning of the formation of lower third molars and each formative stage of lower first premolars, second premolars, and second molars, with the highest correlations noted for second molars.
2. If the germ of the lower third molar has not appeared by stage 7 of lower second molar formation, the probability of congenital absence is 100%.
3. The later the formation of the lower third molar, the later the formation of the other teeth, and the formation of the other teeth is even later in individuals with missing lower third molars.
4. In general, delay of tooth germ formation can be considered one of the reasons for the congenital absence of lower third molars.

TABLE 3. Extended

Formation Stage					
3	4	5	6	7	8
—	—	49	78	74	73
		8.9 ± 0.9	9.8 ± 1.1	11.5 ± 1.3	13.3 ± 1.6
—	—	62	80	82	79
		8.8 ± 1.2	10.3 ± 1.1	12.1 ± 1.3	14.4 ± 1.8
—	48	61	79	91	95
	8.5 ± 1.1	9.7 ± 1.2	10.8 ± 1.1	12.3 ± 1.3	14.7 ± 1.7
75	48	65	38	12	2
17.7 ± 1.3	13.5 ± 1.4	15.3 ± 1.4	16.2 ± 1.6	16.7 ± 1.5	18.3 ± 0.7

TABLE 4. Age Comparison Between the 3 Groups at Each Formation Stage [a]

		Formation Stage				
Tooth	Group	4	5	6	7	8
First premolar	E	—	7.4 (1.2)	8.9 (1.3)	10.5 (1.6)	12.4 (1.3)
	L	—	8.5 (0.9)††	10.5 (1.6)†††	11.8 (1.6)†††	13.1 (1.8)†
	M	—	8.4 (0.9)§§	10.5 (1.3)§§§	12.3 (1.7)§§§	14.2 (2.3)‡§§
Second premolar	E	—	8.1 (1.0)	9.5 (1.0)	11.5 (0.6)	13.8 (2.4)
	L	—	9.1 (1.5)†††	10.8 (1.5)†††	12.6 (1.4)†††	14.1 (2.4)
	M	—	9.3 (0.4)§§§	11.2 (1.1)§§§	13.0 (2.0)§§§	15.6 (2.8)‡§§§
Second molar	E	7.9 (1.1)	8.8 (1.1)	9.9 (0.7)	11.5 (0.9)	13.7 (2.2)
	L	9.0 (1.5)††	10.2 (1.6)†††	11.1 (1.2)†††	12.5 (1.2)†††	14.6 (1.8)††
	M	9.2 (1.2)§§§	11.1 (1.2)‡§§§	11.5 (1.6)§§§	13.7 (2.0)‡§§§	16.2 (2.4)‡§§§

[a] Values are expressed as median (interquartile range [IQR]) age in years. The IQR was obtained by subtracting the 25th percentage value from the 75th percentage value. E indicates early formation group; L, late formation group; and M, missing group.

†, ‡, § Symbols (used singly or multiply) indicating the value with larger significant differences in comparisons between the E and L groups, the L and M groups, and the E and M groups, respectively.

†, ‡ $P < .05$.

††, §§ $P < .01$.

†††, §§§ $P < .001$.

TABLE 5. Coefficient of Rank Correlation Between Age at Beginning of Formation of Lower Third Molar and Formation Stage of Each Tooth

	Formation Stage				
Tooth	4	5	6	7	8
First premolar	—	.582**	.654**	.615**	.389*
Second premolar	—	.664**	.552**	.568**	.330*
Second molar	.798**	.789**	.723**	.731**	.501**

* $P < .01$.

** $P < .001$.

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