Prevalence and patterns of tooth agenesis among malocclusion classes in a Japanese orthodontic population

Shin Ota¹, Chika Hirakata², and Toshiya Endo³

¹Department of Orthodontics and Dentofacial Orthopedics, Graduate School of Life Dentistry at Niigata, The Nippon Dental University, Niigata, Japan
²Orthodontic Dentistry, The Nippon Dental University Niigata Hospital, Niigata, Japan

Abstract: The purpose of the present study was to assess, in detail, the association between tooth agenesis (TA) and various sagittal skeletal malocclusion groups in a Japanese orthodontic population. One thousand and twenty patients were divided into skeletal Class I, II, or III malocclusion groups using the A point, nasion, and B point angle. TA was identified in each group using panoramic radiographs. Patients with Class III malocclusion exhibited a significantly higher prevalence of third molar (M3) agenesis, bilateral and overall agenesis of the maxillary M3s than those patients with a class II malocclusion. Those with a Class II malocclusion demonstrated a significantly lower prevalence of overall agenesis of the mandibular M3s than those with class I or III malocclusions. There were no significant differences in the prevalence of agenesis of teeth other than the M3s between the skeletal malocclusion groups. In each group, there was significantly more M3 agenesis present in the maxilla than in the mandible, and agenesis of the incisors and second premolars was found more often in the mandible than in the maxilla. Sagittal jaw relationships were significantly associated with M3 agenesis but were not associated with agenesis of the maxillary and mandibular incisors and second premolars.

Keywords: tooth agenesis, third molar, incisor, second premolar, sagittal skeletal malocclusion

Introduction

Tooth agenesis (TA) constitutes the most common dental anomaly of the permanent dentition [1]. The prevalence of TA has been reported in various populations [2,3]. Several studies have reported that the prevalence of third molar (M3) agenesis is significantly higher in the maxilla than in the mandible [4,5], while others have shown no consistent findings as to whether jaw has more missing teeth (MT) other than the M3s [6,7]. Most studies have revealed no significant differences in gender in the prevalence of TA [5,6]. In the Caucasian population, the most common congenitally missing teeth (CMT), excluding the M3s, are the mandibular second premolars (MnP2s), followed by either the maxillary second premolars (MxP2s) [8] or the maxillary lateral incisors (MxI2s) [7]. Mandibular incisor (MnI) agenesis exhibits a higher prevalence in the Asian population, including the Japanese [6] and Koreans [9].

Several studies have found no significant differences in the prevalence of TA among different sagittal jaw relationship groups [10-12]. Others have reported that agenesis of the M3s depends on sagittal skeletal malocclusion [5] and that TA is significantly less common in skeletal Class II malocclusions [13]. Celikoglu and Kamak [5] noted that skeletal Class III malocclusions have a significantly higher prevalence of M3 agenesis than skeletal Class I and Class II malocclusions. Some studies have verified that Class III and Class II patients had a higher [9] and a lower [13] prevalence of agenesis of teeth other than the M3s, respectively. Studies in Caucasian [14] and Brazillian orthodontic populations [11] have noted that the A point, nasion, and B point (ANB) angle significantly decreases with an increasing number of CMT, excluding M3s. Very few studies have found that skeletal Class III malocclusions exhibit a high prevalence of agenesis of the MxI2s [15] and the premolars [11]. These studies did not investigate, in detail, the distribution or pattern of TA among different skeletal malocclusions.

The aim of this study was to assess in detail the association between TA and different skeletal malocclusion groups in a Japanese orthodontic population.

Materials and Methods

The Local Committee of Ethics of the Nippon Dental University at Niigata approved this study (ECNG-R-315).

A total of 5,252 Japanese orthodontic patients (3,279 females and 1,973 males) were reviewed from the files at the Nippon Dental University Niigata Hospital (Niigata, Japan). The selection criteria included: 1) available lateral cephalograms and panoramic radiographs in patients older than 14 years of age, 2) no previous orthodontic treatment, 3) no congenital craniofacial deformities and 4) no previous extractions of any permanent tooth. This age limitation was based on the statement that the upper age limit for agenesis of the M3s, which are the last teeth to mineralize, was 14 years old [16]. M3s were included in this study. All panoramic radiographs (Veraview epocs X550, Morita Corporation, Kyoto, Japan) and lateral cephalograms (UD150L-30F, Shimadzu Corporation, Kyoto, Japan; CX-150SK, Asahiroentgen Industry Corporation, Kyoto, Japan) were obtained using the same system.

A study sample of 1,020 patients (665 females and 355 males) was selected from 5,252 patients who were initially reviewed and divided into malocclusion groups after the cephalometric assessment of the ANB angle: Class I (1.5-5.1° for females and 0.8-4.8° for males), Class II (>5.1° for females and >4.8° for males), and Class III (<1.5° for females and <0.8° for males). These groups were classified based on the Japanese norms for the ANB angle (3.3° ± 1.8° for females and 2.8° ± 2.0° for males) [17]. Class I included 407 patients (269 females and 138 males), Class II included 342 patients (238 females and 104 males), and Class III included 271 patients (158 females and 113 males). Four thousand two hundred and thirty-two patients were excluded as they did not meet the inclusion criteria.

A power analysis determined that 145 subjects would be required in each group to determine a significance with an effect size of 0.3, a power of 0.95, one degree of freedom, and an alpha error probability of 0.05 [18].

The first ANB angle measurement was conducted by an investigator (SO) who randomly selected 50 lateral cephalograms and performed a second measurement 3 months later. Paired t-test did not reveal any significant errors between the first and second measurements (P > 0.5). Random errors, assessed using the Dahlberg formula [19], were found to be <0.4°.

TA was evaluated using panoramic radiographs obtained in patients older than 14 years of age. Agenesis was diagnosed when there was no identification of crown mineralization on the panoramic radiographs. TA was re-examined by the same investigator (SO) after an interval of 2 months. Intra-examiner reproducibility for the identification of TA was 100%.
Results

There were no significant differences in the prevalence of agenesis of either M3s or other teeth between the sexes in each malocclusion group. Therefore, the values for males and females were combined for all other analyses.

Table 1: Subjects by the number of missing teeth in each skeletal malocclusion group

| Class   | n   | Agenesis of third molars   | Kruskal-Wallis test | Steel-Dwass test |
|---------|-----|---------------------------|---------------------|------------------|
| I       | 407 | 0 286 (70.3) 1 33 (8.1) 2 61 (15.0) 3 8 (1.9) 4 19 (4.7) | P < 0.01 | NS |
| II      | 342 | 0 264 (77.2) 1 29 (8.5) 2 32 (9.3) 3 6 (1.8) 4 11 (3.2) | NS | NS |
| III     | 271 | 0 169 (62.4) 1 34 (12.5) 2 45 (16.6) 3 7 (2.6) 4 16 (5.9) | P < 0.01 | NS |

Table 2: Prevalence of tooth agenesis in each skeletal malocclusion group

| Class   | n   | Agenesis of third molars   | \chi^2 test with Bonferroni correction (OR, CI) |
|---------|-----|---------------------------|------------------------------------------------|
| I       | 407 | 0 121 (29.7) 1 36 (10.5) 2 0 (0.0) 3 0 (0.0) 4 0 (0.0) | NS |
| II      | 342 | 0 78 (22.8) 1 20 (5.8) 2 4 (1.2) 3 4 (1.2) 4 0 (0.0) 5 2 (0.5) | NS |
| III     | 271 | 0 102 (37.6) 1 13 (4.8) 2 7 (2.6) 3 2 (0.7) 4 0 (0.0) 5 4 (1.5) | NS |

Table 3: Prevalence of different patterns of third molar agenesis in each skeletal malocclusion group

| Class   | n   | Maxilla | \chi^2 test with Bonferroni correction (OR, CI) |
|---------|-----|---------|------------------------------------------------|
| I       | 407 | Unilateral 41 (10.0) 27 (7.9) 25 (9.2) | NS (1.30, 0.78-2.17) |
| II      | 342 | Unilateral 59 (14.5) 34 (9.9) 51 (18.8) | NS (1.53, 0.98-2.40) |
| III     | 271 | Unilateral 100 (24.5) 61 (17.8) 76 (28.0) | NS (1.50, 1.04-2.14) |
| Mandible|     |         |                                               |
| I       | 407 | Unilateral 27 (6.6) 12 (3.5) 21 (7.7) | NS (1.95, 0.97-3.91) |
| II      | 342 | Unilateral 35 (8.6) 20 (5.8) 30 (11.0) | NS (1.51, 0.85-2.67) |
| III     | 271 | Unilateral 62 (15.2) 32 (9.3) 51 (18.8) | P < 0.05 (1.74, 1.10-2.73) |

Discussion

In this study, significant differences were noted in the number of missing M3s between the Class II and Class III groups (Table 1). Additionally, Class II had a higher prevalence of subjects without M3 agenesis (14.8%), and a lower prevalence of two congenitally missing M3s (7.3%) than the Class III group (Table 1). These findings were similar to those of Celikoglu and Kamak [5], who reported a lower prevalence of two congenitally miss-

Statistical Analysis

Significant differences between the classes were estimated with either Fisher’s exact test or the \chi^2 test as appropriate. Results were reported as an odds ratio (OR) with a 95% confidence interval (CI). The Kruskal-Wallis and Steel-Dwass tests were performed to determine any significant differences in the distribution of MT between classes. McNemar test determined if there was significant differences between the prevalence of TA between the jaws. All statistical analyses were performed using Excel-Toukei 2016 for Windows (SSRI, Tokyo, Japan) with P < 0.05.
consistent with those of Endo et al. [1], who noted a high prevalence of or unilateral agenesis of the M3s is significantly higher in the maxilla than of M3 agenesis in Class II malocclusions than in Class I and Class III study by Huang et al. [20], who noted a significantly lower prevalence the MnM3s than in Class I and Class III (Table 3). This is similar to the [23]. In this study, Class II exhibited a lower prevalence of agenesis of demonstrated that Class III malocclusions exhibited a significantly shorter M3s than in those with all of these teeth. This consideration was supported agenesis was significantly increased. Sugiki et al. [23] noted that the maxil- a decrease in the maxillary length, the prevalence of MxM3 and MnM3 -a bilateral and overall agenesis of the MxM3s (4.2%) in Class II malocclusions than in Class III.

The most common number of congenitally missing M3s, in order of frequency, was two teeth, followed by one, four, and three in each skeletal malocclusion group (Table 1). This is similar to the number reported in other studies [1]. Other studies have noted the order of frequency for congenitally missing M3s to be one tooth, followed by two, four, and three teeth [5]; and one tooth, followed by two, three, and four teeth [20].

No significant differences were observed in the number of CMT other than the M3s among the malocclusion groups (Table 1); this is the first documentation of this information to the best of the authors’ knowledge. This study demonstrated that the prevalence of M3 agenesis (Table 2), and bilateral and overall agenesis of the MxM3s (Table 3), was significantly higher in Class III than in Class II. The higher prevalence of M3 agenesis is similar to that of other studies which reported Class III malocclusions to have a higher prevalence of M3 agenesis than Class II malocclusions [5, 21]. The high prevalence of these agenesis patterns in Class III malocclusions might be caused by the shorter maxillary length, as noted by Kajii [22] and Sugiki et al. [23]. Kajii et al. [22] demonstrated that with a decrease in the maxillary length, the prevalence of MxM3 and MnM3 agenesis was significantly increased. Sugiki et al. [23] noted that the maxillary length was significantly shorter in subjects with agenesis of all four M3s than in those with all of these teeth. This consideration was supported by the results of the one-way analysis of variance and Turkey’s test, which demonstrated that Class III malocclusions exhibited a significantly shorter maxillary length (Ptm-A distance) than Class I and Class II malocclusions [23]. In this study, Class II exhibited a lower prevalence of agenesis of the MnM3s than in Class I and Class III (Table 3). This is similar to the study by Huang et al. [20], who noted a significantly lower prevalence of M3 agenesis in Class II malocclusions than in Class I and Class III malocclusions.

Almost all the comparisons have shown that the prevalence of bilateral or unilateral agenesis of the M3s is significantly higher in the maxilla than in the mandible in each malocclusion group (Table 3). These findings are consistent with those of Endo et al. [1], who noted a high prevalence of unilateral and bilateral agenesis of the MxM3s to be characteristic of Japanese orthodontic patients.

There have been reports that the complete absence or deficiency of the MSX-1 homeodomain may cause orofacial clefts, abnormalities of the malleus, nasal, frontal, and parietal bones, as well as TA [24, 25]. Pax-9 deficiency has been shown to be responsible for both skeletal deficiency and M3 agenesis [26]. These findings support the association of a shorter maxillary length with M3 agenesis, which was noted using the measurement of the Ptm-A distance. From a clinical perspective, in orthodontic treatment of Class II malocclusions with severe anterior maxillary crowding and a large overjet, the first [27] or second maxillary molars [28] are extracted with or without the maxillary premolars, if maxillary M3s with functional anatomy are present. For this reason, the present findings that Class II malocclusions have a high prevalence of MxM3s may be convenient for orthodontists treating these malocclusions, as the MxM3s can be used instead of the extracted first or second maxillary molars.

In this study, no significant differences were found in the prevalence of agenesis of teeth other than the M3s (Table 2). In addition, there was no difference in unilateral, bilateral, or overall agenesis of specific teeth (Mx2s, Mn1s, MxP2s, and MnP2s, Tables 4 and 5) between the malocclusion groups. While this is consistent with the findings of some studies [10, 12], other studies have indicated that Class III patients have a higher prevalence of agenesis of teeth other than the M3s than their patients with TA [9]. Costa et al. [11] have found Class III malocclusions to be significantly associated with the agenesis of the premolars, Celikoglu et al. [15] found this to be the case with the Mx2s.

In each of the malocclusion groups in this study, Mx2s, Mn1s, MxP2s, and MnP2s tended to be absent more commonly in the mandible than in the maxilla (Tables 4 and 5). These findings are consistent with previous studies in Korean [9] and Chinese populations [29]. The studies by Celikoglu [13] and Gomes [30] reported findings that were opposite to the ones of the current study, in Turkish and Brazilian populations, respectively; although these differences were not significant. The high prevalence of agenesis of teeth other than the M3s in the mandible, compared with the maxilla, may
be characteristic of Asians, including the Japanese population.

In conclusion, sagittal jaw relationships are significantly associated with third molar agenesis, but not the agenesis of the maxillary and mandibular incisors and second premolars.

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Conflict of Interest
None of the authors have a conflict of interest to declare in relation to this study.

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