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Original Article

Comparison of the Angulation of the Unerupted Mandibular Second Premolar in Turkish Population with Tooth Agenesis

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ABSTRACT

Objective: This study aimed to evaluate the unerupted mandibular second premolar (MnP2) angulation in individuals with different tooth agenesis in Turkish population.

Methods: We retrospectively reviewed panoramic radiographs of patients treated at Akdeniz University. According to the agenesis, the subjects were categorized into three groups: 22 patients with unilateral MnP2 agenesis (Group 1), 22 patients with bilateral mandibular incisor agenesis (MnI, Group 2), and 22 patients with no agenesis excluding third molars (Group 3). The angle between the first mandibular molar and unerupted MnP2 (ɣ angle) and the angle between the mandibular basis and unerupted MnP2 (Θ angle) were measured on both the right and left sides in Groups 2 and 3 using the method determined by Shalish et al.

Results: Groups 1 and 2 were compared with the control group with respect to (ɣ) and (Θ). No significant difference was found between Groups 2 and 3 on both the right and left sides ($p>0.05$). The comparison between Groups 1 and 3 revealed significant differences in the ɣ and Θ angle only on the left side ($p>0.05$).

Conclusion: Posterior rotation of the mandibular condyle during the growth-development period may be one of the factors responsible for the difference in the Θ angle between the MnI agenesis and control groups. A difference in the total number of teeth on the dental arch may be a reason for the differences in the ɣ angle between the MnI agenesis and control groups.

Keywords: Tooth agenesis, unerupted second premolar, hypodontia

INTRODUCTION

Dental agenesis is one of the most common cases of dental anomalies in humans (1). The relationship between dental agenesis and other dental anomalies that may lead to malocclusion has been a topic of research, especially for orthodontists. Delayed tooth development/eruption is included in these dental anomalies (2).

Mandibular second premolar (MnP2) agenesis occurs most frequently in European population (3), whereas mandibular incisor agenesis (MnI) is more common in Asian population (4, 5).

The incidence of malocclusion in MnP2 agenesis is evaluated in terms of orthodontics (6). To assess the relationship between malocclusion and MnP2 agenesis, the presence of various dental anomalies and the distal angulation of the unerupted MnP2 in the contralateral area have been investigated. Panoramic radiographs have been used to determine distal angulation, and usually, consistent results have been obtained (6-8).

Various studies have shown that distal angulation of the MnP2 is greater in patients with agenesis than in patients who have no MnP2 agenesis (6, 7). It has been reported that genetic factors may explain differentiation of

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MnP2 distal inclinations in those with mandibular incisive agenesis and unilateral MnP2 agenesis (9).

When distal inclinations were examined throughout the formation stages of the unerupted MnP2 tooth, it was observed that the angle between the mandibular basis and the tooth increased with the progress of the development (10).

In the literature, a limited number of studies examine the change in the angulation of unerupted MnP2 in cases with agenesis (9). In the studies, the change of the angulation of unerupted MnP2 due to lack of teeth was investigated, but the change of these angles according to different age groups was not investigated without age factor.

This study aimed to:

- Evaluate the unerupted mandibular second premolar (MnP2) angulation in individuals with different tooth agenesis in Turkish population.
- Compare with past studies involving patients with unilateral MnP2 and bilateral mandibular incisive agenesis.
- Evaluate the angle of eruption according to age.

METHODS

Ethical approval of this retrospective clinical study was obtained from the local ethics committee of Antalya Training and Research Hospital. The panoramic radiographs of patients (7210 patients) treated at the School of Dentistry of Akdeniz University between March 2014 and January 2017 were retrospectively reviewed. Written consent was obtained from all patients who applied to our clinic for treatment purposes, indicating that their radiographs or materials can be used in scientific articles. Among the panoramic radiographs examined, it was aimed to form groups of patients with unilateral MnP2 agenesis (Group 1), patients with bilateral MnI agenesis (Group 2), and patients with no agenesis excluding third molars (Group 3). For the sample size, the archive was scanned to determine how many patients were in accordance with our criteria. Then power analysis was done, confirming that our sample size (n=22) was sufficient. Radiographs taken during periods when the unerupted MnP2 teeth were between the D-G phases, according to the Koch Classification (11), were included in the study. If there was more than one radiograph that matched the criteria, the most recent one was selected. Patients who met the inclusion criteria were selected from the patients who were examined. The exclusion criteria for the study were the presence of any systemic disease or syndrome that causes agenesis, the presence of orthodontic treatment history, and the absence of a panoramic radiograph suitable for measurement.

Table 1. Comparison of the chronological ages and gender distributions between the groups

Parameter	Group 1 Mean±SD	Group 2 Mean±SD	Group 3 Mean±SD	p
Gender (*n*)				
Female	14	13	14	0.742 * (NS)
Male	8	9	8	
Age (year)	9.51±0.93	9.62±0.67	9.40±0.48	0.563 ** (NS)

p: * Pearson Chi-square test. ** Student's t-test. SD: standard deviation
p>0.05: NS: non-significant

The mean age of the patients was 9.51±0.69 years (range 7.9-12.1 years). According to the agenesis, the subjects were categorized into three groups: 22 patients with unilateral MnP2 agenesis (8 males, 14 females, mean age 9.51±0.93 years), 22 with bilateral MnI agenesis (9 males, 13 females, mean age 9.62±0.67 years), and 22 no agenesis excluding third molars (8 males, 14 females, mean age 9.40±0.48 years). Patient characteristics are presented in Table 1.

Angular measurements were made on panoramic radiographs of the patients. The angle between the first mandibular molar and unerupted MnP2 (ɣ angle; Figure 1) and the angle between the mandibular basis and unerupted MnP2 (Ө angle; Figure 1) were measured on both the right and left sides in Groups 2 and 3 using the method determined by Shalish et al. (8) and Baccetti et al. (12). In patients with unilateral MnP2 agenesis, only the Ө angle was measured in the contralateral area, which included the MnP2. Comparison of the angulation of the MnP2 between the unilateral MnP2 agenesis group with the control group and bilateral MnI agenesis group with the control group is shown in Table 2.

The same researcher repeated all tracings and measurements to determine the reliability of the measurements. The repro-

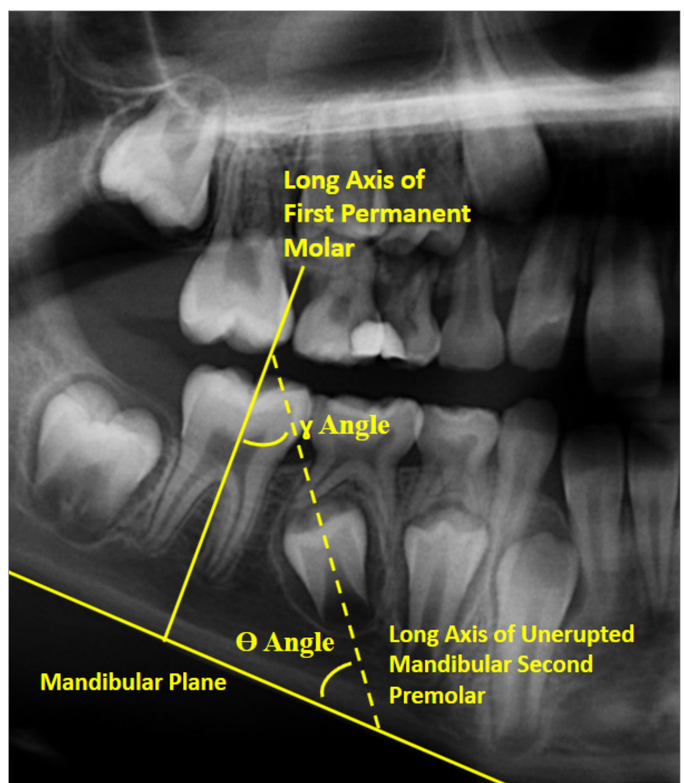

Figure 1. Measurement of angulation of unerupted MnP2 in panoramic radiograph [Distal angle (Ө) and Premolar-molar angle (ɣ)]

Table 2. Statistical comparison between unilateral MnP2 and bilateral MnI agenesis groups with control group

	Right Side				Left Side			
	(Θ) Angle Mean±SD	**p**	**(γ) Angle Mean±SD**	**p**	**(Θ) Angle Mean±SD**	**p**	**(γ) Angle Mean±SD**	**p**
Unilateral Agenesis Group (Group I)	77.15±8.58	0.319	16.60±9.89	0.123	75.78±17.3	0.01	17.65±18.38	0.01
Control Group (Group III)	76.76±9.56		14.54±6.49		78.85±8.11		12.81±6.45	
	(Θ) Angle Mean±SD	p	(γ) Angle Mean±SD	p	(Θ) Angle Mean±SD	p	(γ) Angle Mean±SD	p
Bilateral Agenesis Group (Group II)	70.57±16.64	0.889	20.05±12.96	0.419	65.11±15.82	0.456	27.58±17.81	0.254
Control Group (Group III)	76.76±9.56		14.54±6.49		78.85±8.11		12.81±6.45	

p: Student's t-test. SD: standard deviation
p: p<0.05: * (Level of Significance), p>0.05: NS: non-significant

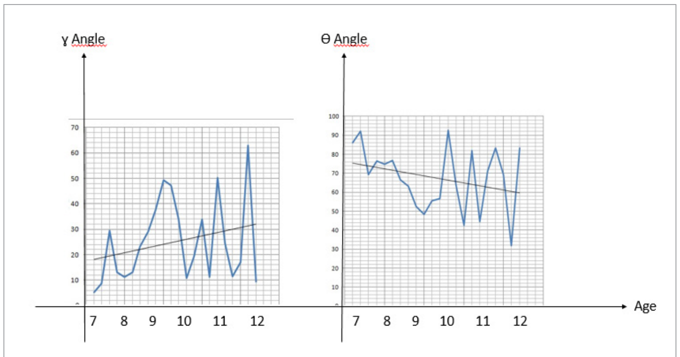

Figure 2. Distribution of (Θ) - (γ) angles according to age and trend line in bilateral MnI agenesis group

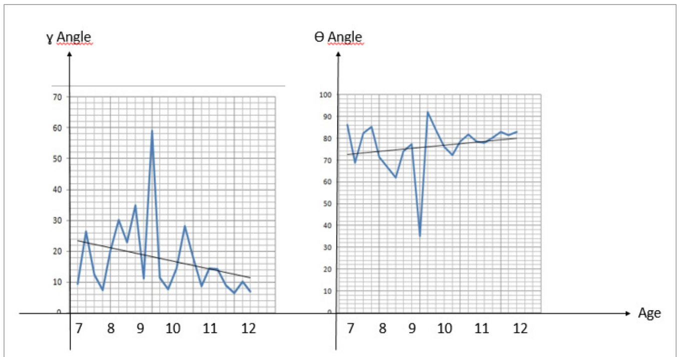

Figure 3. Distribution of (Θ) - (γ) angles according to age and trend line in unilateral MnP2 agenesis group

ducibility coefficients of all measurements were quite high. Parametric tests were performed for data analysis because Shapiro-Wilks test showed normal distribution. Gender distribution was tested by Pearson Chi-square test. The chronological ages and statistical comparison between the groups were achieved using Student's t-test. All statistical analyses were performed using the Statistical Package for Social Sciences software package program for Windows 98, version 10.0 (SPSS Inc, Chicago, IL, USA). The significance level was set at p<0.05 for all statistical tests.

RESULTS

No significant differences between the groups were found in terms of the gender distribution and chronological age (p>0.05; Table 1). Groups 1 and 2 were compared with the control group (Group 3) with respect to (γ) and (Θ), and no significant difference was found between Groups 2 and 3 in on both the right and left sides (p>0.05). In the comparison between Groups 1 and 3, there were significant differences in the γ and Θ angle only on the left side (p<0.05). The γ angle in Group 1 was significantly larger than in Group 3, while the Θ angle was significantly smaller in Group 1 than in Group 3 (Table 2).

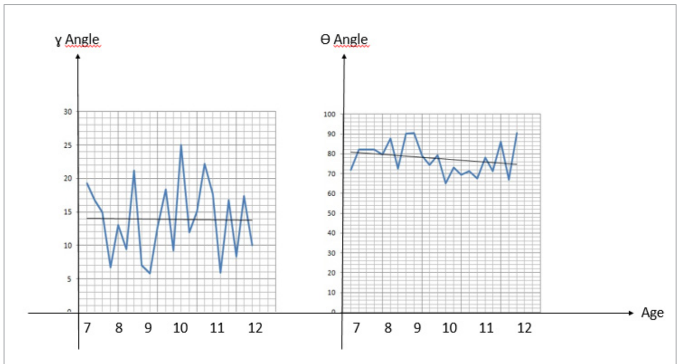

Figure 4. Distribution of (Θ) - (γ) angles according to age and trend line in control group

When the patients were aligned according to age in each groups, the trend line of the γ angle on the graphs decreased, whereas the trend line of the Θ angle increased in Group 2 (Figure 2). The trend line of the Θ angle showed a decrease when the linear trend line of the γ angle increased in the contralateral area in Group 1 (Figure 3). On the control group graphs, there was a decrease in the trend line for both the γ and Θ angles (Figure 4).

DISCUSSION

This study aimed to evaluate the incidence of MnP2 distal angulation and angle of eruption in individuals in the Turkish population. In addition, with different aspects, the reliability of MnP2 distal angulation has been tested according to change with age. The MnP2 distal angulation in patients with unilateral MnP2 hypodontia was found to be higher than in patients without agenesis. The Θ angle trend line increased in the patients with MnI agenesis, whereas the Θ angle trend line decreased in the control group with age. These results indicate that many factors may effect change in both the ɣ and Θ angles with age, such as genetic factors, dental abnormalities, and the growth-development process.

In studies of hypodontia conducted in European, American, and Australian societies, MnP2 agenesis was found to be the most common type of hypodontia (3, 13, 14), while mandibular incisive hypodontia was found to be the most common in Asian population (4, 5). It has also been reported that the prevalence of hypodontia in North America is lower than in Europe and Australia (3). Studies conducted in Turkish society have also observed a similar prevalence of hypodontia in European population (15, 16). If the genetic factors are considered to affect the type of hypodontia seen in societies, it can be said that Turkish society is similar to European societies rather than Asian societies in terms of hypodontic characteristics.

In our study, the unerupted MnP2 distal angulation in patients with unilateral MnP2 hypodontia was found to be higher than in patients without agenesis as in both European and Japanese studies (7, 9). Navarro et al. (7) stated that MnP2 distal angulation is associated with genetic features of dental abnormalities. Kure et al. (9) in a study comparing MnP2 distal angulation between a MnI agenesis group and unilateral MnP2 agenesis group stated that different genetic factors affect type of agenesis. This situation may suggest that genetic factors do not predominantly affect the physical and quantitative characteristics of the hypodontia that has occurred, while they do affect the type of hypodontic prevalence that will occur. Aside from genetic factors, local factors such as mesial inclination of the permanent first molars due to early loss of a primary second molar or anklyloses primary molars below the occlusal level may also be responsible for the angular measurements between the long axis of the molar and the premolar. Otherwise, vertical growth pattern may have an important influence on the mesial angulation of the molars and premolars.

In association with the unerupted MnP2, increasing of Θ angle value has been shown in recent studies during the progressive phases of the formation (10). It can be said that the change in Θ angle starts with by rotation toward the vertical of the unerupted MnP2 tooth during progression of the formation and the posterior rotation of the mandibular condyle and angulus with the effect of growth and development (17). It should be expected that the vertical rotation of the MnP2 increases the Θ angle, while the posterior rotation of the mandibular condyle decreases. In the same process, a decrease in the ɣ angle due to acquired vertical direction of the MnP2 tooth with progression of the formation process should be expected. The graphs obtained from age-matched patients within their own groups can provide insight regarding the differences in the angles during the formation stages, as well as the differences in the ɣ and Θ angles in different agenesis groups and in the control group.

In their study, Wasserstein et al. (10) showed that the Θ angle increased as the formation stages progressed. Navarro et al. (7) showed similar results in both the control group and unilateral MnP2 agenesis group depending on the developmental stage. Kure et al. (9) found that the Θ angle of the control group was significantly higher than the Θ angle of the unilateral MnP2 agenesis group and numerically a little higher than the Θ angle of the MnI agenesis group. In our study, the Θ angle trend line increased in the patients with MnI agenesis (Figure 2), whereas the Θ angle trend line decreased in the control group (Figure 4). This situation is related to using different measurement techniques or to the measurement errors between the two studies. Also, it can be said that distal angulation measurements obtained with panoramic radiography may not always present clinically accuracy results. In addition, in our study, it was thought that MnP2 in the control group may have a more vertical direction, and the effect of posterior rotation of the mandibular condyle during growth-development on the Θ angle may be higher. Thus, a decrease in the Θ angle in the control group was reached in this study. The reason the rotation in the condyle had more of an effect on the Θ angle than change of the MnP2 in the vertical direction in our study can be explained by the genetic factors because the studies were conducted in different societies. Similarly, in our study, the trend line of the Θ angle decreased in the control group, although it increased in patients with MnI agenesis. The reason for this may be that the posterior rotation of the condyle is greater in the control group than in the MnI agenesis group, which may be related to the genetic factors. In other words, it can be said that the change of the Θ angle according to the developmental stage can be determined by degree of dominance of the condylar rotation and MnP2 vertical direction.

Furthermore, Navarro et al. (7) found that the ɣ angle decreases according to developmental stage and explained that these findings are related to genetic factors. In our study, the tendency of the ɣ angle to decrease in the control group was very unclear, whereas the trend line of the ɣ angle showed a high tendency to decrease in patients with MnI agenesis. In addition, it was found that the values of the inclination graphic according to age in both groups were very close. This may be due to errors/differences in measurement and genetic factors, the same way the presence of more space on the dental arch for teeth due to hypodontia in patients with MnI agenesis may result in this finding, compared to patients without agenesis. In addition, the difference in the graph slopes due to the eruption path of the MnP2 teeth may be more rotational in the MnI agenesis group, and more linear in the non-agenesis control group patients.

In the group of patients with unilateral MnP2 agenesis, when the trend line of ɣ angle increases with age, the decrease in the trend line of Θ angle shows that it does not meet the expectation in terms of changes in the angle values (Figure 3). This finding supports past studies (7-9) that showed the value of the ɣ angle of MnP2 in the contralateral area in unilateral MnP2 agenesis was significantly higher than in the control group, and the ϴ angle was significantly lower than in the control group. In other words, this finding can be interpreted as the possibility of malocclusion in patients with unilateral MnP2 agenesis being higher, which may be caused by genetic factors.

Because using panoramic radiography in our study may have caused erroneous values due to limitations in 2D imaging, few studies using 3D imaging techniques would be helpful to obtain more reliable results. In other words, distal angulation measurements obtained with panoramic radiography might not always present clinically accuracy results. New studies should be undertaken to support the past studies and our study using techniques involving more reliable measurements to achieve more reliable results, including a larger patient population.

CONCLUSION

- In unilateral MnP2 agenesis, the ɣ angle of the MnP2 in the contralateral was higher than in the control group, and the ϴ angle was lower than in the control group.

- The results obtained in the group with unilateral premolar agenesis support the literature in terms of age-related changes in angle of eruption.

- Posterior rotation of the mandibular condyle during the growth-development period may be one of the factors responsible for the difference in the ϴ angle between the MnI agenesis and control groups. The difference in the total number of teeth on the dental arch may be a reason for the reason for the differences in the ɣ angle between the MnI agenesis and control groups. Also, local factors such as mesial inclination of the permanent first molars due to early loss of a primary second molar or anklylosis of the primary molars below the occlusal level may also be responsible for the angular measurements between the long axis of the molar and premolar.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of Antalya Training and Research Hospital.

Informed Consent: Written informed consent was obtained from the patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - S.S.; Design - S.S., M.H.B.; Supervision - S.S., M.H.B.; Materials - S.S., M.H.B.; Data Collection and/or Processing - S.S.; Analysis and/or Interpretation - M.H.B.; Literature Search - S.S., M.H.B.; Writing Manuscript - S.S., M.H.B.; Critical Review - S.S., M.H.B.

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