

## Assessing the Accuracy of Mandibular Second Molar Tooth Development in Estimating Chronological Age

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### Abstract

**Introduction:** Teeth are used as a valuable factor in the estimation of age since external factors have a lower impact on mineralization of the tooth compared to bone. The most commonly-used method in this regard is the Demirjian method, which is based on the process of calcification of teeth. The objective of this study was to assess the accuracy of mandibular second molar development in estimating chronological age.

**Materials and Methods:** This study is a cross-sectional and diagnosis test study. A total of 240 panoramic radiographs were obtained from 6 - 25 years old men and women. The chronological age of the subjects was recorded by their birth date and analyzed using SPSS version 20 software.

**Results:** Independent t-test showed that there was no significant difference between mean ages in right and left in each of the calcification stages ( $P > 0.05$ ). Also, the test indicated that there was only a significant difference between the mean ages of groups C and H in boys and girls ( $P < 0.05$ ). In other age groups, there was no significant difference between the mean ages of boys and girls ( $P > 0.05$ ). Investigating of mean ages in different groups of A-H and calculation of error percentage showed that the highest percentage of error (40%) was in group A and the lowest (-1.23) was in group H.

**Conclusion:** The most important factor affecting the process of dental calcification is chronological age and gender has little effect on it.

**Keywords:** Estimation of Legal Age; Panoramic Radiograph; Demirjian Method; Nolla Method

### Introduction

The need to determine age has increased in the last decade. It is important not only on crimes and determining the age of victims of crimes but also for estimating chronological age in relation to school, employment, immigration, conviction and marriage [1]. Determining of chronological age in the age range of 10 - 23 years remains a problem despite various age estimation methods such as skeletal indicators of the cervical spine, wrist bone, fusion of skull seams. All methods have positive and negative aspects, but they are uncertain in this age group [2]. Teeth are used as a valuable factor in estimating age. Environment, genetics, hormones, and nutritional factors can all influence one's growth, but external factors clearly have less impact on tooth mineralization compared to bone [3]. The third molar tooth is a tooth that its development level can be used to estimate age in this group [4]. However, the third molar cannot be used sometimes to estimate age. These cases include congenital missing of this tooth, tooth extraction due to orthodontics and evolutionary anomaly. Therefore, to overcome these limitations, the second molar can be used to estimate age [3].

Many studies have been conducted in different populations so far to assess age estimation methods using the evolutionary stages of the second molar tooth. The studies have also shown that mineralization and development of teeth are unique in each population, so using an age-specific estimation method is required for each population [5]. Different methods are used to assess the stages of dental development and mineralization. Dental development can be measured in two ways, including the growth of teeth and the rate of their calcification [2]. Dental growth is a discontinuous process that is affected by factors such as malnutrition and premature loss of milky teeth and crowning and tooth decay, but the rate of calcification is more valid and has a lower coefficient of variation [2]. The most commonly used method is the Demirjian method that is based on the process of calcification of teeth [6]. In the Demirjian method, calcification of teeth is divided into eight stages (A-H). Having specified evolutionary stages has been reported as one of the strengths of this method [7].

Sisman., *et al.* (2007) in Turkey investigated the relationship between chronological age and growth of the wisdom tooth and concluded that the use of the third molar tooth as a developmental marker is appropriate for estimation of the age of people [1]. In another study conducted in Karadayi., *et al.* by 2012, third molar teeth were examined in a population of Turkey and concluded that third molar tooth can be used to estimate age [5]. Manuella Santos and Carneiro Almeida., *et al.* in 2013 examined the relationship between chronological age and developmental stages of second molar tooth using the Demirjian method in the Brazilian population. They concluded that the use of the second molar tooth as a developmental marker is appropriate for estimating the age of people and there was a significant relationship between the mandibular and maxillary teeth [8].

In another study conducted in 2017, Pedro Fins., *et al.* estimated the age by using the rate of mineralization of the mandibular permanent second molar tooth based on the Demirjian method and showed that there was no statistically significant difference between the real age and the estimated age of the samples [9]. In another similar study conducted by Guo YC on 1657 panoramic radiographs to estimate the age using the rate of mineralization of the second molar according to the Demirjian method in 2017, the results showed that the second molar tooth in stage G of above 14 years of age and observing of the second molar tooth in stage H do not exclude the age of above 18 years [10]. Thus, since many studies have been conducted to estimate the chronological age using third molar tooth and since this tooth is absent in some people, little information is available on the second molar tooth developmental stages and its effect on estimation of legal age in the Iranian population and considering the accuracy of the Demirjian method in estimating the age and extensive use of age estimation in forensic medicine, the present study was conducted to assess the accuracy of mandibular second molar tooth development in estimating chronological age.

## Materials and Methods

This study is a cross-sectional and Diagnosis test study. In this study, a total of 240 panoramic radiographs were obtained from 6 - 25 years old individuals. The sample size in the present study to examine the correlation between estimated age and calcification factors of the maxillary second molar tooth was estimated at maximum of 8 patients with considering 95% confidence level and test power of 95%, which it could be increased up to 30 patients in each stage of calcification given all possibilities. Finally, a total of 240 panoramic radiographs were considered.

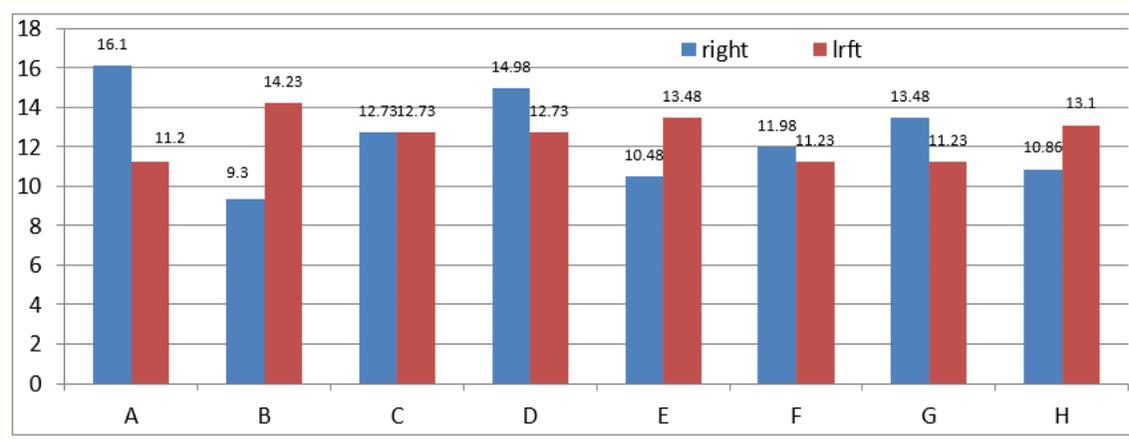
$$n = \frac{Z_{\alpha,\beta}^2}{\left[\frac{1}{2} \ln\left(\frac{1+r}{1-r}\right)\right]^2} + 3$$

To conduct this study, a minimum of 8 radiographs were considered for each gender in each age group. During examining of the radiographs, the chronological age of the subjects was recorded using their birth date. Dental growth and development were assessed by the Demirjian method and they were divided into 8 categories. The first 4 categories belonged to calcification of the crown, from the cusp emergence to its completion (A-D) and the second category belonged to root formation from initiation of bifurcation to apex closure (E-H). In stage A, the cusps are mineralized but not interconnected. In stage B, the mineralized cusps are connected and the morphology of

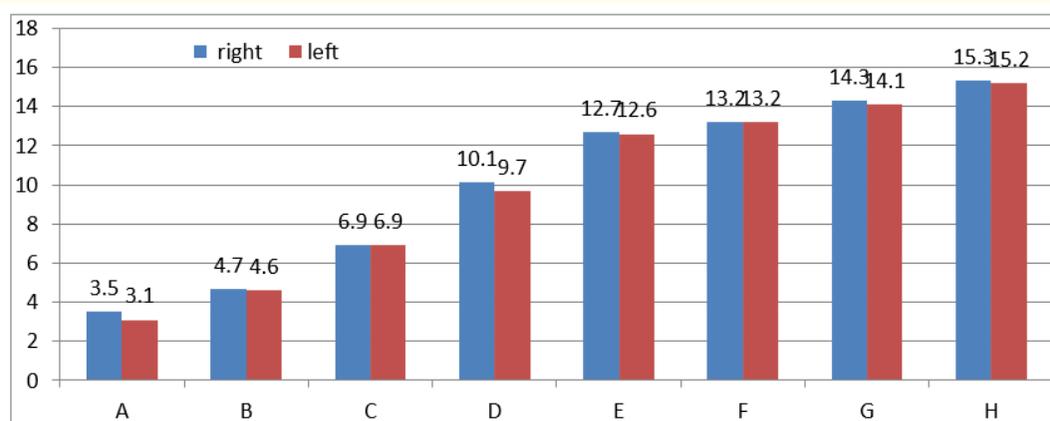
the coronal region is determined. In stage C, half of the crown is formed and dentin deposition occurs. In stage D, crown formation up to DEJ is completed and the chamber pulp is trapezoidal. In stage E, the formation of furcation starts and the length of the root is less than that of the crown. In stage F, the root length is the same as the crown length. In stage G, the root walls are parallel but the apex is open. In stage H, the apex is closed. Before conducting this study, 20 radiographs were independently observed by a radiologist and a trained dentistry student and observers' agreement was calculated. Then, if the agreement was high, the two jaw radiographs were studied and classified. The observers' results were recorded in the data collection form. Inclusion criteria included lack of systemic disease or any medical or surgical history affecting the tooth growth, lack of obvious dental pathology, and presence of at least one mandibular second molar tooth, and exclusion criterion included inappropriate panoramic quality. The data were analyzed using SPSS Version 20 software and paired t-test, Pearson's linear correlation coefficient, and linear regression. The formula of error =  $\frac{\text{measured value} - \text{real value}}{\text{real value}} \times 100$  was used to calculate the measurement error.

**Results**

In this study, a total of 534 samples including 266 males and 268 females were evaluated according to inclusion and exclusion criteria. The age of the patients showed that the mean age of the female patients was 10.02 years, ranging from a minimum of 2.5 to a maximum of 16.5 years, and the mean age of the males was 9.8 years, ranging from a minimum of 2.3 to a maximum of 16.5 years, and the total mean age of the patients was 9.96 years (Figure 1 and 2).



**Figure 1:** Comparison of the percentage of frequency in each of the calcification stages of right and left second mandibular molar teeth.



**Figure 2:** Comparison of the chronological age in each of the calcification stages of the right and left mandibular second molar teeth.

Independent t-test showed that there was no significant difference between mean age on the right and left in each of the calcification stages ( $P < 0.05$ ). In other words, it is similar in each stage of mean age development on the right and left sides (Table 1).

Demirjian criterion	Right	Left	P-value
A	97.0 ± 51.3	45.0 ± 13.3	03.0
B	03.2 ± 74.4	80.1 ± 61.4	804.0
C	85.0 ± 99.6	85.0 ± 99.6	999.0
D	49.0 ± 75.9	49.0 ± 75.9	995.0
E	02.1 ± 74.12	97.0 ± 69.12	828.0
F	38.0 ± 29.13	38.0 ± 29.13	121.0
G	97.0 ± 33.14	02.1 ± 19.14	590.0
H	83.0 ± 34.15	76.0 ± 28.15	768.0

**Table 1:** Mean and standard deviation of age on the left and right sides based on the stages of second molar tooth development (Demirjian criterion).

Also, the test showed that only in the C and H age groups, there was a significant difference between the mean age group of boys and girls ( $P < 0.05$ ). Underestimation occurred in the age group C and overestimation occurred in group H in girls. In other age groups, there was no significant difference between mean ages in boys and girls ( $P < 0.05$ ) (Table 2).

Demirjian criterion	Boys	Girls	P value
A	58.0 ± 18.3	33.0 ± 10.3	619.0
B	69.0 ± 44.4	97.2 ± 96.4	405.0
C	91.0 ± 39.7	56.0 ± 60.6	005.0
D	49.0 ± 75.9	77.0 ± 75.9	995.0
E	03.1 ± 89.12	87.0 ± 46.12	189.0
F	36.0 ± 20.13	40.0 ± 42.13	121.0
G	97.0 ± 50.14	02.1 ± 96.13	159.0
H	53.0 ± 62.15	81.0 ± 00.15	013.0

**Table 2:** Mean and standard deviation of age in two groups of boys and girls according to left second molar tooth development (Demirjian criterion).

Investigating the mean age in different A to H groups and calculating of error percentage showed that the highest error level (40%) was observed in age group A and the lowest (-1.23) was seen in the age group H.

### Discussion

Many studies have been conducted so far on the evaluation of second molar teeth mineralization and its relationship with the age of individuals. However, recent studies have shown that the process of mineralization of teeth is unique in each population, so the use of indicator and source unique to each population is required to estimate age using the process of mineralization of teeth. Given the anatomic and growth variations of the third molar tooth and lack of a sufficient history of a second molar tooth, the present study was conducted to assess the accuracy of the Demirjian method in estimating age using 534 individuals referred to a private maxillofacial imaging clinic.

Their panoramic radiographs were digitally prepared. The mean age of the women was 10.02 years, ranging from a minimum of 2.5 years to a maximum of 16.5 years. Also, the mean age of male patients was 9.8 years, ranging from a minimum of 2.3 years to a maximum of 16.5 years.

In the Demirjian method, based on the development and mineralization of the second molar tooth, 8 age groups from A to H are introduced. Based on the results of this study, the mean age of the individuals on the left and right sides was not significantly different. Also, only in the C and H age groups, there was a statistically significant difference between the mean ages of girls and boys. Investigating the mean age in different A to H groups and calculation of percentage of error showed that the highest percentage of error was in age group A and the lowest was in age group H. In a similar study, Al Balushi S., *et al.* [11] in 2018 investigated the age estimation using the Demirjian method in 2018. They concluded that the Demirjian method is more appropriate for estimating the age of younger people. The inconsistency between the results of the present study and the above-mentioned studies might be attributed to the differences in the study population. In another study conducted by Moness Ali [12] in 2019, the use of the Demirjian method in estimation of age was examined. They stated that the Demirjian method was more accurate in the older age group. As seen, their results are consistent with those of the present study. In a study conducted in 2019, Yang., *et al.* [13] investigated the accuracy of the Demirjian and Willemz methods in estimation of age and found that the estimation of age was more accurate in using the Demirjian method. In another study, Fins., *et al.* [9] in 2017 investigated the accuracy of the Demirjian method using the evolutionary process of the mandibular second molar tooth and stated that there was a significant difference between the real age and the estimated age of the samples in the older age group. Their results are in line with those of the present study.

Lee., *et al.* (2010) also examined the Demirjian method to estimate age using the evolutionary process of the second molar tooth and they found that it was an appropriate and accurate method. Their results are in line with those of the present study. Pourtaji., *et al.* [14] conducted a study to evaluate the chronological age and calcification of third molar teeth using the Demirjian method and stated that the Demirjian method was more accurate in the higher age groups. Their results are also consistent with those of the present study. High diversity in the results of the studies is observed in comparing the mean age of each of the stages of the Demirjian development method in males and females. It is attributed to differences in the studied populations. In a study conducted in Sweden and Japan, results showed that teeth develop earlier in boys compared to girls. However, in a study conducted by Israel, the time stages of teeth development were not significantly different between boys and girls. In the present study, the mean age of girls and boys was significantly different only in the C and H age groups and the mean age was higher in girls and development of teeth in these two age groups occurred earlier in girls than boys. The significance of the difference between the two genders can be attributed to the difference in the growth pattern of the jaw and teeth, which is a hereditary feature.

### Conclusion

The results of this study showed that chronological age was the most influential factor in the process of dental calcification and gender had little impact on it. Also, the present study showed that the Demirjian method was more accurate in higher age groups.

### Bibliography

1. Sisman Y., *et al.* "Third-molar development in relation to chronologic age in Turkish children and young adults". *The Angle Orthodontist* 77.6 (2007): 1040-1045.
2. Bagherpour A., *et al.* "Dental age assessment of young Iranian adults using third molars: a multivariate regression study". *Journal of Forensic and Legal Medicine* 19.7 (2012): 407-412.
3. Rai B., *et al.* "Dental age estimation from the developmental stage of the third molars in Iranian population". *Journal of Forensic and Legal Medicine* 17.6 (2010): 309-311.

4. Mohtavipour ST, *et al.* "Radiographic evaluation of third molar development in relation to chronological age in Gilani children and adolescents (2011): 14-23.
5. Karadayi B, *et al.* "Radiological age estimation: based on third molar mineralization and eruption in Turkish children and young adults". *International Journal of Legal Medicine* 126.6 (2012): 933-942.
6. Braga J, *et al.* "Non-adult dental age assessment: correspondence analysis and linear regression versus Bayesian predictions". *International Journal of Legal Medicine* 119.5 (2005): 260-274.
7. Zeng DL, *et al.* "Chronological age estimation of third molar mineralization of Han in southern China". *International Journal of Legal Medicine* 124.2 (2010): 119-123.
8. Almeida MSC, *et al.* "The chronology of second molar development in Brazilians and its application to forensic age estimation". *Imaging Science in Dentistry* 43.1 (2013): 1-6.
9. Fins P, *et al.* "Chronology of mineralization of the permanent mandibular second molar teeth and forensic age estimation". *Forensic Science, Medicine and Pathology* 13.3 (2017): 272-277.
10. Lee S-S, *et al.* "The chronology of second and third molar development in Koreans and its application to forensic age estimation". *International Journal of Legal Medicine* 124.6 (2010): 659-665.
11. Al Balushi S, *et al.* "Dental age estimation of Omani children using Demirjian's method". *The Saudi Dental Journal* 30.3 (2018): 208-213.
12. Moness Ali AM, *et al.* "Applicability of Demirjian's method for dental age estimation in a group of Egyptian children". *BDJ Open* 5 (2019): 2.
13. Yang F, *et al.* "Dental age estimation through volume matching of teeth imaged by cone-beam CT". *Forensic Science International* 159 (2006): S78-S83.
14. Pourtaji B and Nasiri A. "Evaluation of Relationship between Chronological Age and Calcification Stages of Mandibular Third Molars Patients Referring to a Dento Maxillofacial Radiology Centre in Zanjan". *Journal of Advances in Medical and Biomedical Research* 25.111 (2017): 104-114.

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