

# Age Estimation Methods in Forensic Dentistry

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## Abstract:

Predicting the dental age of an individual which is comparable to his/ her chronological age is crucial in forensic dentistry. Different age estimation methods have been formulated for different age groups. Here, some studies are analysed to compare the methods of age estimation that have been currently used. The variability of each method in their accuracy, applicability and reliability was a problem. This reinforces recommendations on the need to develop an ideal method.

**Keywords:** Age estimation, Forensic dentistry

## Introduction

Age estimation of an individual plays an important role in forensic medicine and odontology for the identification as well as for crimes and accidents. The chronological age of a person can be best assessed by dental maturity since the dental indicators show less variability. Even though teeth, skeleton or both the structures can be used as maturity indicators, teeth maturation has been used to estimate the age since ages<sup>1</sup>.

Almost all the methods used for dental age estimations are based on the process of tooth development, which is an organized and accurate process and is controlled more by genetic factors rather than environmental and nutritional factors. Teeth have a vital role in identification during mass disasters and decomposed post-mortem remains. Because teeth are the strongest structures present in the human body and are highly resistant to external factors<sup>2</sup>.

## Discussion

Age estimation has applications in both post-mortem reconstructive identification as well as living individuals

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in whom the chronological age is disputed. The age estimation using the dentition can be grouped into 3 phases,

1. Prenatal, Natal and post natal period
2. Children and adolescents
3. Adults.

Demirjian's method is most widely used for the age assessment in children and adolescents. In 1973 Demirjian and his co-workers have developed this method to assess the age of children and adolescents using mandibular left side teeth. The method originally excluded third molar. Later modification was made and third molar was included. Even though this is a widely accepted method, variations were found between the actual age and predicted age among different populations. So, many studies were conducted to assess the reliability of Demirjian's method in different populations.

R.M.R Eid et al conducted a study in Brazilian children aged 6-14 years to assess dental maturity using the Demirjian's method. In their study, Brazilian children were significantly more advanced in dental maturity compared to Demirjian's French-Canadian sample, supporting the need for population specific standards<sup>3</sup>.

Similar studies were done in many populations. According to Staaf et al, when they assessed orthopantomograms of 574 Spanish and Portuguese children and adolescents (both males and females), Demirjian's method overestimated the chronological age for both sexes. The same overestimation was reported in North German and South Indian Populations also<sup>4</sup>.

All these studies have questioned the applicability of Demirjian's method in wide populations. From these studies, it is evident that Demirjian's method cannot be accurate for all the populations and this reinforces recommendations on the need to develop population-specific standards.

Indian population specific formula was developed by Ashith B Acharya and he compared the effectiveness of this formula with Demirjian's formula in terms of mean absolute error between the predicted age and actual age. On assessing 547 Indians aged 7-25 years, the India specific formula revealed better age prediction than that of Demirjian's formula with no over estimation or under estimation. The accuracy was also higher with a mean absolute error close to half year less than the original formula<sup>5</sup>.

In some studies, third molar development was assessed to predict 18 years of age. In many countries including India, 18 years of age is at which a person is legally considered to have attained adulthood. This is very important legally to estimate the majority and minority status.

A study was conducted to test the accuracy of predicting 18 years of age from mandibular third molar development in 221 Indian subjects of the age range 15-21 years, using Demirjian's method. This was able to identify a minor or juvenile correctly upto 85.7% while the ability to correctly identify a major or adult was up to 60% only. Among the group of <18 years, only 17 years aged subjects were wrongly categorized as major. Similarly the subjects in >18 years old group, 18 or 19 years aged subjects had shown a tendency to be categorized as minors. In  $\geq 18$  years old age group, if the developmental grade is 8 or 9, then it is correctly categorized as major and in the <18 years old group, with developmental grade less than  $\leq 7$  are correctly categorized as minors. Irrespective of the statistical approach utilized, Demirjian's method can predict an individual's age as < or  $\geq 18$  years in approximately three-quarters of Indian test cases. One in four subjects was categorized wrongly into minor or major age groups. But this level of accuracy is inadequate for the courts of law<sup>6</sup>.

After the eruption, teeth get influenced by age as well as numerous exogenous and endogenous factors and cause some differences between the chronological and dental age. This makes the age estimation process of adults a challenging one.

The age estimation methods are of 3 types.

1. Morphohistologic methods
2. Radiological methods
3. Biochemical methods

Gustafson's method, based on the morphological and histological changes of teeth was proposed by Gosta Gustafson in 1950. The age changes used in this method were,

1. Attrition (A)
2. Secondary dentin deposition (S)
3. Apical migration of periodontal attachment (P)
4. Cementum apposition at the root apex (C)
5. Root resorption at the apex (R)
6. Root dentin translucency (T)

Four grades ranging from 0-3 were assigned for each of these changes. Total score will be obtained by adding the allotted grades of each variable. As the age advances, the total score was found to be increasing<sup>7</sup>.

Some studies were done to assess the applicability of Gustafson's method in different populations. In 1974 Sivasankara Pillai and Bhaskar conducted a study in Indian population using Gustafson's method. In India, an average error rate of about  $\pm 8$  years was obtained while the original Gustafson's method gave error of just  $\pm 3.6$  years. No sex difference was found in various age groups but, the lower teeth got little higher values than the upper teeth. They concluded that these variations may be due to the chewing habit in India as well as the oral hygiene<sup>8</sup>.

In 2018, a study was conducted to assess Gustafson's age estimation method on a sample of Western Cape adults. For this study, they used extracted maxillary central incisors, mandibular central and lateral incisors. They found that Gustafson's method is inaccurate to the Western Cape adult population<sup>9</sup>.

In 2020, a study was conducted to assess the accuracy of age estimation in Kerala population using Gustafson's formula. 36 cases were selected among the patients who visited for tooth extraction. Age of the patient as well as extend of periodontal disease were noted at the time of extraction itself. Age estimation was done on these extracted teeth using Gustafson's formula, Maples formula and newly derived formula. On comparing the age obtained by these three formulae, they concluded that the applicability of Gustafson's formula in age estimation of Kerala population is not relevant<sup>10</sup>.

Later Johanson modified Gustafson's method as it shows some statistical errors. Instead of four grades, Johanson suggested seven grades - 0, 0.5, 1, 1.5, 2, 2.5 and 3. It is observed that, the more the number of teeth used, more accurate will be the estimated age.

Radiological methods became popular as they only use radiographs, eliminating the need for teeth extraction. It is applicable to both living and dead individuals. This method was based on the fact that as the age advances area of pulp chamber or pulp canal reduces due to secondary dentin deposition. This results in a decrease in the pulp-to-tooth area ratio and can be used as a dental indicator of age. But this method will be inaccurate if the teeth are with some periapical pathologies, rotated, carious or attrited.

In biochemical age estimation, the most accepted methods are Aspartic acid racemization, collagen crosslinks, advanced glycation end products and mitochondrial DNA mutations. The enamel, dentin or cementum of tooth are metabolically stable protein structures. Rapid racemization of amino acids in these structures can be used as a dental indicator. Racemization of L-aspartic acid forms D-aspartic and its amount increases as age advances.

## Conclusion

Numerous methods for age estimation suggested by many author have been reported since date. Each of these methods varied in their accuracy, applicability and reliability. The major drawback of all these studies is their inaccuracy when applied to global population. Population specific standards were introduced to get an accurate dental age which is comparable with chronological age. Even though many age estimation techniques are available, an ideal method is still in research.

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