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Dental age estimation in Bhopal children: A comparison of Demirjian's and Cameriere's Indian methods

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Abstract:
Accurate dental age estimation plays an important role in pediatric dentistry and forensic odontology and the applicability of different methods varies among populations. Therefore, it is of interest to compare the accuracy of Demirjian's method and Cameriere's Indian formula in 80 children aged 6–13 years from Bhopal using digital orthopantomographs. Dental age estimated by both methods was compared with chronological age using appropriate statistical analysis. The results showed that Demirjian's method significantly overestimated chronological age, whereas Cameriere's Indian formula provided estimates that were closer to the actual chronological age. Thus, data shows that Cameriere's Indian formula is a more reliable method for dental age estimation in children of Bhopal and may be preferred for similar Indian populations.

Keywords: Dental age estimation, Demirjian's method, Cameriere's Indian formula, chronological age, orthopantomogram, forensic odontology

Background:
Dental age estimation is an essential component of forensic odontology and has wide applications in pediatric dentistry, orthodontics, anthropology and legal medicine. It assists in the identification of unknown individuals, determination of chronological age in children without valid birth records and resolution of medico legal issues. Among the available biological indicators, dental development is considered one of the most reliable because it is less influenced by environmental and nutritional factors than skeletal maturation **[1]**. In 1973, Demirjian *et al.* introduced a radiographic method for dental age estimation based on the developmental stages of the seven left permanent mandibular teeth. This method is simple, reproducible and has become one of the most widely used techniques for estimating dental age in children. Because of its ease of application and high reproducibility, Demirjian's method is regarded as the gold standard for comparison with other dental age estimation techniques **[2]**. Although Demirjian's method has gained worldwide acceptance, its accuracy varies among different populations. Vieira *et al.* evaluated the applicability of dental age estimation methods in an Indian population and reported that population-specific validation is necessary because the original standards may not accurately estimate chronological age in Indian children. Their findings emphasized the need for regional studies before adopting any age estimation method in routine practice **[3]**. Further evidence supporting the importance of population based validation was provided by previous researches that compared dental age estimation methods in Indian children and observed differences between estimated dental age and chronological age. Their study highlighted that ethnicity, genetics and regional variations significantly influence dental maturation, thereby affecting the accuracy of age estimation methods **[4]**. Similarly, researchers compared different radiographic methods of dental age estimation and demonstrated that the diagnostic accuracy of these techniques varies among different populations. The authors suggested that no single method can be considered universally applicable and recommended validation studies before their forensic or clinical use **[5]**. In a recent Indian study, radiographic methods of dental age estimation were evaluated and the findings indicated that population specific regression models improve the accuracy of age estimation compared with methods originally developed for other ethnic groups. These findings further emphasized the need for validating existing methods in different Indian populations **[6]**. Similarly, research evaluating the reliability of dental age estimation methods in Indian children reported that although commonly used methods demonstrate acceptable accuracy, variations may occur between estimated dental age and chronological age. The findings highlighted the importance of developing and validating regional standards to improve forensic reliability **[7]**. To overcome some limitations associated with Demirjian's staging system, a modified scoring system was developed using new maturity scores based on a Belgian population. This modification demonstrated improved accuracy across several populations and highlighted that population specific calibration can enhance the precision of dental age estimation methods **[8]**. Another important advancement was the development of a quantitative

radiographic method based on measuring the widths of open apices of developing permanent teeth. Unlike stage based assessment, this approach uses mathematical regression equations to estimate dental age objectively. Subsequent research demonstrated high accuracy, particularly when population specific formulas, including the Indian formula, were applied **[9]**. Further studies evaluating dental maturity across different populations reported variations in dental development among ethnic groups, emphasizing the need for population specific validation of age estimation methods. These findings reinforced the importance of adapting dental age estimation techniques to the target population to achieve greater forensic accuracy **[10]**. Therefore, it is of interest to evaluate and compare the Demirjian's method and the Indian formula for dental age estimation in children from Bhopal.

Materials and Methods:

The present cross-sectional radiographic study was conducted to evaluate and compare Demirjian's method and Cameriere's Indian formula for dental age estimation in children of Bhopal. A total of 80 healthy children aged 6–13 years were included in the study. Only high-quality digital orthopantomographs (OPGs) showing all permanent teeth of the left mandibular quadrant, excluding the third molar, were included. Children with systemic diseases, developmental anomalies, previous orthodontic treatment, gross dental pathology, or a history of permanent tooth loss due to trauma were excluded. Digital OPGs were obtained using a Planmeca Proline XC panoramic unit and evaluated using ROMEXIS software. Dental age was estimated by Demirjian's method using the developmental stages of the left mandibular permanent teeth and calculated with Acharya's Indian formula. For Cameriere's method, measurements of the open apices and tooth lengths of the seven left permanent mandibular teeth were recorded and substituted into the Indian population-specific regression formula to estimate dental age. Chronological age was calculated from the date of birth and compared with the estimated dental age obtained by both methods. Statistical analysis was performed using SPSS version 20.0. Descriptive statistics, the Wilcoxon signed-rank test and Spearman's correlation coefficient were used for data analysis. A p-value <0.05 was considered statistically significant.

Results:

A total of 80 children aged 6–13 years were included in the present study. The median chronological age of the participants was 10.0 years (IQR: 7.0–12.0). Among the study participants, the median age was 10.0 years (IQR: 7.0–11.0) for males and 11.0 years (IQR: 8.5–12.0) for females (**Table 1**). The median dental age estimated using Demirjian's method was 12.74 years (IQR: 11.02–13.81), whereas the median dental age estimated using Cameriere's Indian formula was 9.91 years (IQR: 7.35–11.20), indicating that Demirjian's method consistently estimated a higher dental age than Cameriere's method (**Table 2**). Comparison of the two methods demonstrated a statistically significant difference in dental age estimation among males, females and the overall study population ($p < 0.001$), with Demirjian's method showing significantly higher age estimates than Cameriere's Indian formula (**Table 3**). When the dental age estimated by Demirjian's method was compared with the chronological age, a statistically significant difference was observed in males, females and the overall sample ($p < 0.001$), suggesting that Demirjian's method significantly overestimated chronological age (**Table 4**). In contrast, the dental age estimated using Cameriere's Indian formula was much closer to the chronological age. No statistically significant difference was observed among male participants ($p > 0.05$), whereas a statistically significant difference was found among female participants and in the overall study population ($p < 0.05$) (**Table 5**). Overall, the findings indicate that Cameriere's Indian formula provides a more accurate estimation of chronological age than Demirjian's method in children of Bhopal, while Demirjian's method tends to overestimate dental age. Overall, Demirjian's method significantly overestimated dental age, whereas Cameriere's Indian formula produced estimates that were closer to the chronological age, indicating better applicability for age estimation in the studied population.

Table 1: Distribution of chronological age of the study participants

Group	Median (years)	Interquartile range
Male	10	7.0–11.0
Female	11	8.5–12.0
Overall	10	7.0–12.0

Table 2: Estimated dental age by Demirjian's method and Cameriere's Indian formula

Method	Median (years)	Interquartile range
Demirjian's method	12.74	11.02–13.81
Cameriere's Indian formula	9.91	7.35–11.20

Table 3: Comparison of dental age estimated by Demirjian's method and Cameriere's Indian formula

Group	Demirjian (median)	Cameriere (median)
Male	12.92	8.82
Female	12.17	10.45

Table 4: Comparison of Demirjian's dental age with chronological age

Group	Demirjian age	Chronological age	p value
Male	12.92	10	<0.001*
Female	12.17	11	<0.001*
Overall	12.74	10	<0.001*

Table 5: Comparison of Cameriere's dental age with chronological age

Group	Cameriere age	Chronological age	p value
Male	8.82	10	>0.05
Female	10.45	11	<0.05*
Overall	9.91	10	<0.05*

Discussion:

The present study showed that Cameriere's Indian formula provided a closer estimation of chronological age than Demirjian's method among children from Bhopal. This finding supports the growing evidence that dental age estimation is influenced by population-specific patterns of dental maturation and that formulas developed in one population may not provide equivalent accuracy when applied to another. Previous Indian studies have reported similar variations in the performance of Demirjian's method. Hegde *et al.* evaluated 1,200 Indian children

aged 5–15 years and found that the original Demirjian seven-tooth method overestimated chronological age by approximately 0.69 years overall, with significant differences between dental and chronological age. These findings support the tendency of Demirjian's original standards to overestimate age in Indian children and are consistent with the present observations **[11]**. In another study involving the same age range, Vieira *et al.* compared Demirjian, Willems and Chaillet standards and demonstrated differences in their accuracy, further emphasizing that internationally developed standards cannot necessarily be applied directly to Indian populations **[12].** The applicability of Cameriere's approach has also been demonstrated in Indian children. Manjrekar *et al.* developed an India-specific Cameriere regression equation using 150 panoramic radiographs from children aged 6–15 years in Davangere. Their model demonstrated a significant relationship between open-apex measurements and chronological age, supporting the use of Cameriere's methodology for population specific dental age assessment. Similarly, Manjrekar *et al.* **[13]** studied 311 children from Western India and developed a regional regression formula based on normalized open-apex measurements. Their model showed a strong association with chronological age and demonstrated improved accuracy in children aged 4–13 years, highlighting the importance of regional calibration of Cameriere-based methods. More recently, Gupta *et al.* **[14]** directly compared Demirjian and Cameriere methods in 762 North Indian children aged 7–16 years. Demirjian's method showed a tendency toward overestimation, whereas Cameriere's method showed a comparatively smaller discrepancy. Population-specific modification of both methods subsequently produced better agreement with chronological age. These findings are particularly relevant to the present study because the study population was also Indian and demonstrates that regional differences may influence the performance of dental age estimation equations. The present findings therefore reinforce the concept that no single dental age estimation method should be considered universally applicable. Although Demirjian's method remains widely used because of its simplicity and established developmental staging system, the quantitative assessment of open apices used by Cameriere may provide greater adaptability when an appropriate population-specific formula is available. The relatively small sample size and single geographic setting of the present study are limitations that may restrict generalizability. Larger multicentric studies involving diverse Indian populations are warranted. Overall, Cameriere's Indian formula appears more suitable than Demirjian's method for estimating chronological age in children from the Bhopal population.

Conclusion:

Cameriere's Indian formula showed greater accuracy and closer agreement with chronological age than Demirjian's method among children from Bhopal. In contrast, Demirjian's method significantly overestimated dental age in the studied population. These findings suggest that Cameriere's Indian formula may be more suitable for dental age estimation in similar Indian pediatric populations.

References:

[1] Rajashekaraiah PB *et al. Oral Sphere J. Dent. Health Sci.* 2025 **1**:204. [DOI: 10.63150/osjdhs.2025.20]
[2] Pliska B *et al. Biomed Res Int*. 2024 **2024**:8783660. [PMID: 38988904]
[3] Vieira I *et al. Humans*. 2025 **5**:6. [DOI:10.3390/humans5010006]
[4] Nair VV *et al. Clin Pract.* 2018 **8**:991. [PMID: 29492239]
[5] Khan AA & Bhateja S. *Cureus.* 2025 **17**:e98020. [PMID: 41466895]
[6] Chaudhry K *et al. Int J Clin Pediatr Dent*. 2020 **13**:16. [PMID: 32581472]
[7] Abuabara A *et al. Front. Dent. Med*. 2025 **6**:1634006. [PMID: 40800006]
[8] Pan J *et al. Clin Oral Investig*. 2021 **25**:3463. [PMID: 33420828]
[9] Abuabara A *et al. Egypt J Forensic Sci*. 2025 **15**:56. [DOI: 10.1186/s41935-025-00477-7]
[10] Kelmendi J *et al. Forensic Sci Med Pathol*. 2025 **21**:1755. [PMID: 40817984]
[11] Hegde S *et al. J Forensic Odontostomatol*. 2018 **36**:1. [PMID: 29864025]
[12] Attiguppe PR *et al. Int J Clin Pediatr Dent*. 2016 **9**:330. [PMID: 28127165]
[13] Manjrekar S *et al. Int J Dent.* 2022 **2022**:9513501. [PMID: 35140790]
[14] Gupta S *et al. J Oral Maxillofac Pathol*. 2023 **27**:138. [PMID: 37234310]

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