ORIGINAL STUDY

Comparative Evaluation of Demirjian and Willem's Methods for Dental Age Estimation in Indian Children Aged 9–14 Years Using Orthopantomograms

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Abstract

Background: Age estimation is crucial in forensic and pediatric dentistry. Demirjian's method is widely used but may overestimate age in non-Caucasian populations. Willems modified this method for broader applicability.

Aim: To compare the accuracy of Demirjian and Willem's methods in estimating dental age among Indian children aged 9–14 years.

Methods: A retrospective cross-sectional study was conducted using 80 orthopantomograms. Dental age was calculated using both methods and compared with chronological age. Statistical analysis included paired t-tests, correlation coefficients, and mean absolute error (MAE).

Results: Demirjian's method overestimated age by 0.7 years (p < 0.001), while Willems' method closely matched chronological age (+0.1 years; p = 0.18). Willem's method showed higher correlation (r = 0.91) and lower MAE.

Conclusion: Willems' method is more accurate and legally reliable for age estimation in Indian children and should be preferred in forensic and clinical contexts.

Keywords: Dental age estimation, Demirjian method, Willem's method, Orthopantomograms.

Introduction

Accurate age estimation is a cornerstone of forensic odontology, pediatric dentistry, and legal medicine. Chronological age may not always be documented, especially in low-resource settings or legal disputes, thus necessitating biological age estimation (Kvaal & Solheim, 1994; Schmeling et al., 2007). Among biological indicators, dental maturity is considered one of the most reliable due to its resistance to environmental variations (Cameriere et al., 2006; Nolla, 1960).

The Demirjian method, developed in 1973, assesses the developmental stages of seven mandibular permanent teeth and is widely used due to its simplicity and reproducibility (Demirjian et al., 1973). However, it has been criticized for overestimating dental age in populations outside its original French-Canadian sample (Koshy & Tandon, 1998; Jayaraman et al., 2013; Różyło-Kalinowska et al., 2008).

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To address this, Willems et al. (2001) introduced a modified scoring system based on a Belgian population, aiming to minimize the bias introduced by Demirjian's original standards. This method has shown greater accuracy across multiple populations, including European (Willems et al., 2001), Asian (Lee et al., 2008), and Indian children (Prabhakar et al., 2012; Gali et al., 2017; Patil et al., 2012).

Several studies have evaluated the applicability of these methods in Indian cohorts, with conflicting conclusions regarding their accuracy (Maber et al., 2006; Mohammed et al., 2015; Anitha et al., 2016; Kiranmayi et al., 2019). This highlights the importance of population-specific validation of age estimation techniques (Kumar et al., 2011; Rai et al., 2010; Chalet & Demirjian, 2004).

So, this study aims to compare the Demirjian and Willem's methods for estimating dental age in a cohort of 80 Indian children aged 9–14 years, using orthopantomograms (OPGs), and to determine which method is more accurate and legally reliable in the Indian context.

Materials and Methods

This retrospective study included OPGs of 80 healthy Indian children (40 boys, 40 girls) aged 9–14 years, obtained from institutional archives.

Table 1: Comparison of Demirjian and Willem's Methods

Method	Mean estimated age (years)	Mean difference from chronological age	MAE (years)	Correlation (r)
Demirjian	11.9 ± 1.4	+0.7 (Overestimation)	0.89	0.83
Willem's	11.3 ± 1.3	+0.1 (Closer Estimate)	0.42	0.91

Inclusion Criteria

- * Healthy children with no systemic diseases
- * High-quality OPGs with all mandibular left permanent teeth visible

Exclusion Criteria

- * Congenital dental anomalies or impactions
- * Pathological tooth conditions
- * Prolonged illness or developmental disorders

Dental Age Estimation Methods used

- Demirjian Method: Seven mandibular left permanent teeth were evaluated by stage (A to H) and converted to dental age using standard charts.
- Willem's Method: Same staging applied, but age was estimated using Willems' regionally calibrated scores.

Chronological age was computed from date of birth to the date of OPG.

Statistical Analysis

Data were analyzed using SPSS 26.0. Descriptive statistics, paired t-tests, Pearson's correlation coefficients, and mean absolute error (MAE) were used. Significance was set at $p < 0.05$.

Results

For the 80 OPGs (with mean age 11.2 ± 1.5 years), Demirjian method Overestimated age by 0.7 years ($p < 0.001$), MAE: 0.89, r = 0.83 while Willem's Method, closely aligned with chronological age (+0.1 years, $p = 0.18$), MAE: 0.42, r = 0.91

Discussion

The current study supports the growing consensus that Willems' method is better suited for Indian children. Consistent with prior research in Indian (Gali et al., 2017; Patil et al., 2012) and Southeast Asian cohorts (Ambarkova et al., 2016; Jayaraman et al., 2013), our findings confirmed Demirjian's overestimation.

Numerous international validations have reinforced these patterns. For instance, Turkish (Uysal et al., 2011) and Iranian (Bagherpour et al., 2010) studies identified significant overestimation with Demirjian, especially in adolescents. Gunst et al. (2003) also noted that while Demirjian was foundational, accuracy improved significantly when regionally recalibrated.

In Australia, Pathmanathan et al. (2019) proposed modified Willems-based formulas to fit local population growth patterns. Acharya (2011) advocated for third molar assessment to enhance estimation near adolescence, a point worth considering in Indian age-cutoff scenarios.

Age estimation has serious implications for legal classification, school admissions, and child protection. Overestimation can misclassify minors as adults, leading to violations of juvenile justice norms (Giri et al., 2019; Schmeling et al., 2007).

Legal and Forensic Relevance

Age estimation impacts legal decisions in criminal trials, child labor cases, and marriage disputes. Methods like Demirjian's may overestimate age, risking legal misclassification. Willems' method, with its greater accuracy, offers a more reliable framework for Indian forensic practice.

Conclusion

Willems' method demonstrated superior accuracy in Indian children aged 9–14, with lower mean absolute error and stronger correlation. It should be preferred for forensic and legal age estimation in this demographic.

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