Original Research
Journal of Forensic Dental Sciences, *Vol 13(3), DOI: 10.18311/jfds/13/3/2021.660, September-December 2021, p. 131-137*
ISSN (Print) : 0975-1475
ISSN (Online) : 0975-2137

Dental Age Estimation in HIV-infected Children Using Willems Method

Maryam Paknahad[1], Javad Garmabi[2*], Seyedeh Shokufan Hosseini Heravi[3], Hamidreza Pakshir[4] and Mahsa Omidi[5]

[1]Associate Professor, Oral and Dental Disease Research Center, Oral and Maxillofacial Radiology, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran
[2]Postgraduate Student, Oral and Maxillofacial Radiology, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran; javadgarmabi22@gmail.com
[3]Undergraduate Student, Student Research Committee, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran
[4]Professor, Orthodontics Department, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran
[5]Assistant Professor, Oral and Dental Disease Research Center, Oral and Maxillofacial Radiology, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran

Abstract

Objective: HIV patients differ from other people in terms of dental age. Estimating the age of children abandoned due to HIV is crucial for forensic records. The present study aimed to compare HIV-infected children with healthy controls in terms of dental age using the Willems method. **Methods**: The study sample consisted of orthopantomograms of 40 HIV patients aged 5-16 years and 50 children aged 6-16 years as the control group. The HIV group included children with vertical infections who had received antiretroviral therapy. The Willems method was used to compare two groups in terms of dental age. **Results:** Dental age estimation in both HIV and control groups was overestimated using the Willems method. Nevertheless, the overestimation rate was approximately one month in the control group and less than two months in the HIV group, making the method widely applicable for estimating dental age in both healthy children and HIV patients. The dental age of the HIV-infected children was lower than that of the control group. **Conclusion:** This study indicated a lower dental age in the HIV-infected children compared to the control group. The results demonstrated that dental age estimation using Willems method closely approximated the chronological age of HIV patients.

Keywords: Dental Age Estimation, Forensic, HIV, Willems Method

Introduction

Human Immunodeficiency Virus (HIV) or Acquired Immunodeficiency Syndrome (AIDS) was first detected in children in 1983[1]. According to the World Health Organization's (WHO) reports, the prevalence of HIV is increasing[2]. AIDS, which is caused by the development of HIV, makes the body vulnerable to infections and diseases. The virus can be transmitted from individuals with HIV through blood (certain bodily fluids) and sexual contact or vertically from an infected mother to her baby. However, only 51% of infected pregnant women receive treatment or prophylaxis to stop vertical transmission[3].

Vertical transmission plays a pivotal role in forensic records, as children mostly lose their HIV-infected family members and remain lonely and unsure of their identities. In addition, HIV-infected children are often left on the streets[4]. The forensic specifications of the deceased in the absence of comparative data before death are fundamentally valuable for identification[4].

**Author for correspondence*

In legal processes, determining age is important in terms of both punishment and the law[5]. Age identification can be correlated to physical, skeletal, and dental maturity as well as with the identification of corpses[2]. There are many methods for estimating age based on such important factors as the quality and quantity of the dead body remains, environmental conditions, cost, time, and the required equipment[6,7]. Due to the highly resistant nature of teeth, they can be suitable biological markers for age estimation[7]. Estimating dental age is a useful way to determine calendar age[8]. It is the most commonly used assessment in pediatric endocrinology as well as in forensic, legal and clinical dentistry[5].

The scientific literature has recommended calculating dental age as the best way to estimate age in children. Dental age estimation has shown the least error in children[9]. Dental age estimation is usually requested in cases involving child abuse, abandoned children, adoption, legal consent, emigration and asylum steps[4,10]. Estimation of dental age has been accepted because it has less variability than other indicators and is less influenced by environmental factors[11,12]. Up to now, many methods, including anatomy, histology, tooth histology and radiology have been used to estimate tooth growth[7-9,13-15]. Among these methods, radiology is the most practical and reliable. Dental age can be assessed by the date of tooth eruption or the progression of tooth calcification. Various methods have also been proposed to determine tooth maturity using radiography[9,13,16-18].

The Willems method is a simple system that assesses tooth age by giving important information about the scores determined for each step of a single tooth[17]. These scores are then turned into years by utilizing the Willems sex-specific tables[19]. Willems, *et al.,* applied Demirjian's dental scores to a Belgian population sample and showed a significant overestimation of age. Therefore, they proposed a modified technique for estimating dental age based on scores of dental maturity, expressed by year, for children of both genders. In forensic medicine, the Willems technique has been confirmed as a valid method for estimating dental age, and many scholars have examined the validity and application of this dental scoring method in different populations[9]. To date, Few studies have examined tooth growth in HIV patients[1,4]. Therefore, the purpose of this study was to evaluate and compare the chronological and dental ages of HIV patients and healthy controls and to determine the use of Willems method in these patients.

Materials and Methods

The present study was approved by the Institutional Research Committee. The sample included orthopantomograms (OPGs) of 90 children, 40 vertically infected HIV-positive patients (the study group) and 50 HIV-negative children (the control group). The control group was aged 6-16 years (mean age = 10.08 years, SD = 2.24) and did not have any previous history of pathologies or medical treatments with known date of birth, gender and date of image acquisition. This group included 20 males (40%) and 30 females (60%) and their dental ages ranged from 6.79 to 15.79 years (mean = 10.17 years, SD = 2.16). The participants in this group were selected via selective sampling to ensure that their age and sex distributions were similar to those of the patients in the HIV group, so as to avoid arbitrary effects on the results. The study group included 21 males (55%) and 19 females (45%). The chronological ages ranged in this group from 5 to 16 years (mean = 9.98 years, SD = 2.78), while their dental ages ranged from 5.49 to 16.04 years (mean = 10.08 years, SD = 2.71). This group included vertically infected children with known date of birth, gender and date of image acquisition. All the participants in this group used antiretroviral therapy. The inclusion criteria were aging 5-16 years with good image quality, absence of systemic diseases, dental anomalies, and having clear birth dates and radiography dates. The exclusion criteria were unacceptable image quality such as motion artifacts, magnification, rotation of the patient's head (unequal tooth size on both sides), and the lack of one or more permanent teeth in the left mandible. All the participants were informed about the investigation's topic and were required to sign a written satisfaction form.

The participants' panoramic radiographs were obtained from the archives of the patients who needed radiographs for dental evaluation. All panoramic radiographs were obtained using ProMax® (Planmeca Oy, Helsinki, Finland). Dental age estimation used the Willems method was applied by two experienced examiners. The chronological age of each person was defined as the duration of one's life after birth by subtracting the date of birth from the radiograph acquisition date. The images were independently assessed twice, with a minimum interval of 14 days. The dental age estimation was achieved considering the mean age of the two analyses reported by the examiners (Figure 1). Figure 2 showed an estimation of dental age in a sample patient. The differences between the estimated and chronological ages were calculated separately for males and females.

Student paired t-test was accomplished to investigate the association between dental ages of HIV and control groups. Furthermore, the two groups' real and estimated ages were compared using a student paired t-test. A statistical significance level of 5% was considered.

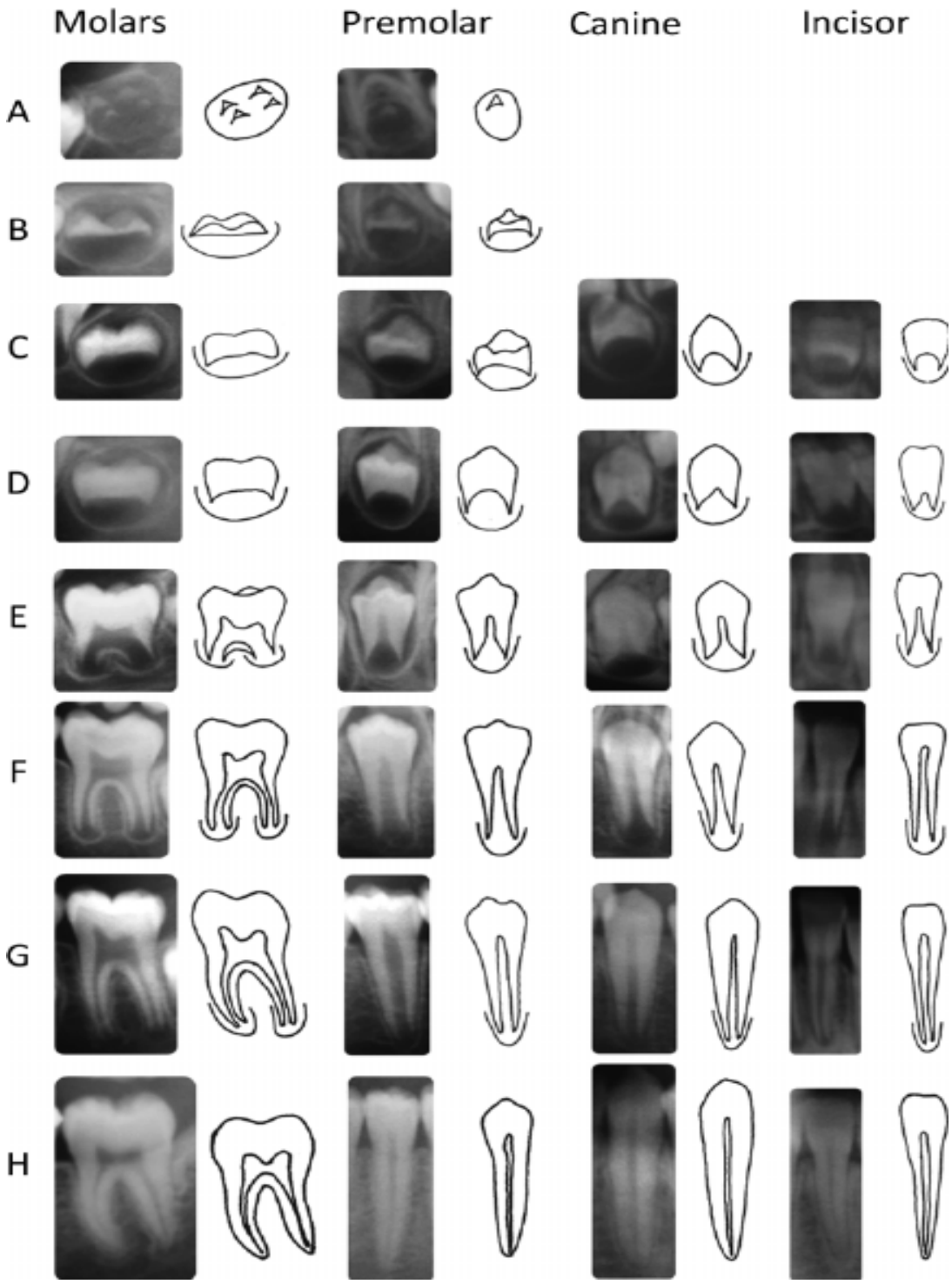

Figure 1. Assessment of tooth formation stages of the left mandibular second molar, first molar, premolars, canine, and incisors. The sum of the scores from Willems table equals the dental age.

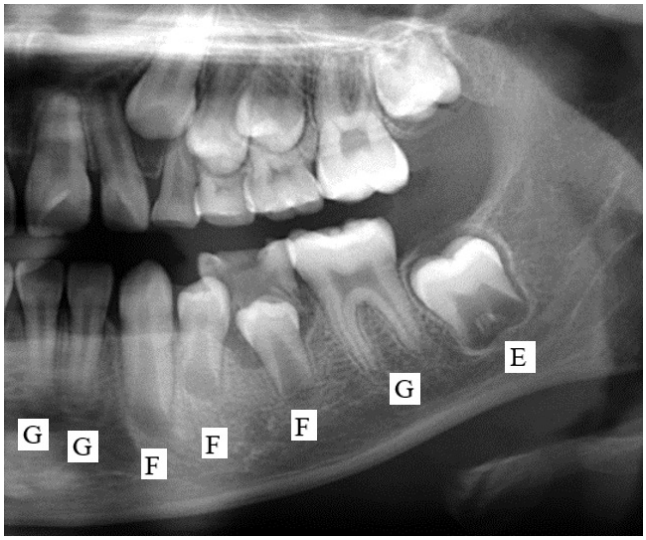

Figure 2. Estimation of dental age in panoramic image of a nine-year-old girl.

Results

The intra- and inter-examiner agreement tests for dental age estimation using this method indicated high reproducibility for the two examiners (ICC1 = 0.88 and ICC2 = 0.95, respectively). The definitive statistics for the dental and chronological ages of both HIV and control groups are presented in Table 1. The results indicated no significant differences between the chronological and dental ages of the children with HIV and the control groups (Table 2). In other words, the dental ages of both sexes in the two groups were comparable to their chronological ages.

The results indicated by Willems method the age of the children in both HIV and control groups was overestimated. Nonetheless, the overestimation rate was about one month in the control group and less than two months in the HIV group, making the method widely applicable for dental age estimation in healthy children and HIV-infected patients. According to Table 2, 0.10-year and 0.09-year overestimations were noticed in the HIV group ($p = 0.431$) and the control group ($p = 0.498$), respectively. In addition, the overestimation rate was 0.16 years in the HIV-infected males ($p = 0.435$) and 0.12 years in the healthy males ($p = 0.586$). Besides, the overestimation rate was 0.09 years in the healthy females ($p = 0.667$) and 0.05 years in the HIV-infected ones ($p = 0.785$). The results revealed no significant differences between the control and healthy groups as well as between males and females in each group with respect to the overestimation rate ($p > 0.05$).

In this study, in the HIV-infected children, the dental age was lower than in the control group. However, no statistically significant differences between the two groups in terms of dental age were observed (Table 3).

Table 1. Definitive statistics for chronological and dental ages of both HIV and control groups

	Control Group		HIV Group	
	Chronological age	**Dental age**	**Chronological age**	**Dental age**
Mean	10.08(2.24)	10.17(2.16)	9.98(2.78)	10.08(2.71)
Minimum	6.00	6.79	5.0	5.49
Maximum	16.00	15.79	16.00	16.04

Results expressed in years; SD: standard deviation

Table 2. Mean differences between the dental and chronological ages of the HIV and control groups based on gender

	Control group				HIV group		
Gender	**Chronological age**	**Dental age**			**Chronological age**	**Dental age**	
	Mean (SD)	**Mean (SD)**	**P'**		**Mean (SD)**	**Mean (SD)**	**P'**
M + F	10.08 (2.24)	10.17 (2.16)	0.498		9.98 (2.78)	10.08 (2.71)	0.431
M	10.00 (2.30)	10.12 (2.04)	0.586		9.57 (2.85)	9.73 (2.81)	0.435
F	10.12 (2.24)	10.21 (2.27)	0.667		10.42 (2.71)	10.47 (2.62)	0.785

M: males; F: females; results expressed in years; SD: standard deviation Student paired t-test

Table 3. Comparison of dental age between the HIV and control groups based on gender

Gender	Dental age (control group)	Dental age (HIV group)	P'
	Mean (SD)	Mean (SD)	
M + F	10.17 (2.16)	10.08 (2.71)	0.931
M	10.12 (2.04)	9.73 (2.81)	0.624
F	10.21 (2.27)	10.47 (2.62)	0.709

M: males; F: females; results expressed in years; SD: standard deviation Student paired t-test

Discussion

The medical literature has supported the growth rate retardation in HIV-infected children[20]. Researchers have largely attributed growth retardation to 1) the direct effect of HIV itself and 2) the side effects of antiretroviral therapy. HIV potentially interferes with physical growth and causes significant changes in dental tissue and bone growth[4]. To the best of our knowledge, however, the significance of estimating the age of abandoned HIV-infected children in the forensic casework has remained unsupported.

The current study's findings revealed similar dental development in HIV-infected patients and non-infected children. Similar results were also obtained by Fernandes, *et al.,* and Rafael Boschetti de Souza, *et al*[4,21]. Moreover, no significant difference was detected between the chronological age and the dental age in the HIV and control groups ($p > 0.05$). Rafael Boschetti de Souza, *et al.,* and Fadi Titinchi, *et al.,* also revealed no significant difference between HIV patients and the control group concerning dental age[1,4]. However, Sibelle Buonora, *et al.,* and M. Trigueiro, *et al.,* a delay in the dental age of HIV-infected children have been reported[20,22].

As mentioned earlier, researchers have attributed growth retardation more to the direct effect of HIV itself and the side effects of the antiretroviral treatment. It has been claimed that HIV can interfere with somatic growth, the culmination of pivotal changes in tooth-related tissues, and bone development. Antiretroviral treatment has been claimed to decline the systemic consequences of the virus itself. Nevertheless, this method of treatment usually involves toxic and aggressive drugs, including protease inhibitors. These inhibitors are famous for their associations with metabolic and bone disorders[20]. Thus, it was hypothesized in the present study that HIV-infected children would have retarded dental development in comparison with normal children. Although the results showed a slight delay in dental development in the HIV group, the difference was not statistically significant. These results were supported by those of other studies[1,4].

In the current research, the overall mean difference between the chronological age and the estimated dental age was 0.16 years for the HIV-infected males ($p = 0.435$) and 0.05 years for the HIV-infected females ($p = 0.785$). Moreover, the mean difference between the chronological age and the dental age was 0.12 years for healthy males ($p = 0.586$) and 0.09 years for healthy females ($p = 0.667$). Hence, Willems method was more accurate for girls, which was confirmed in other studies[4,5].

Dental age estimation using the Willems method is a comparatively simple system. In contrast to the previously admitted statements suggested by Demirjian for examining the developmental stages of seven permanent teeth of the left mandible, Willems method evaluates the dental age by providing crucial information about the scores assigned to each stage of a single tooth[23]. In fact, Willems technique is a modified version of Demirjian's method that involves making new tables from which a maturity score can be directly expressed in years. This modification has been evaluated in several populations and more accuracy than Demirjian's method has been reported[15,24,25]. Many researchers, when Demirjian's method was applied to their populations reported a significant overestimation[15,26]. Thus, Willems, *et al.,* simplified the age estimation by directly converting maturity scores into age and modified Demirjian's method based for a Belgian population. Willems technique resulted in smaller overestimations in males and females[16]. Up to now, limited studies have been done on the applicability of Willems method for age estimation among children[4,5]. According to the available literature, dental age estimation with the Willems method provides lower overestimations of age compared to other methods. It is, therefore, for forensic purposes reliable

and accurate to be utilized[9]. In the current study, this method was used for age estimation.

The study results indicated that Willems method overestimated the dental age of the children in both the HIV and control groups. Yet, the overestimation rate was about one month in the control group and less than two months in the HIV group. The age overestimation in normal children using Willems method was previously confirmed by other studies[4,23]. Similarly, Rafael Boschetti[4] revealed age overestimation in both HIV and control groups. On the contrary, two studies disclosed age underestimation using Willems method[13,27]. Ali Alqerban, *et al.,* found that the difference in the mean absolute error for predicting age was close enough to zero (0.03) to be considered clinically irrelevant[14]. The discrepancy observed between the results might be justified by the differences in sample size, age groups, ethnic differences, age and gender distributions, and utilized statistical methodologies.

Conclusion

The results indicated no significant differences in dental age between the control and HIV groups. Additionally, no significant difference was observed between the dental age and the chronological age in the two study groups. Furthermore, the results demonstrated that dental age estimation using Willems method closely approximated to the chronological age of HIV-infected patients.

References

1. Titinchi F and Behardien N. Dental development in a sample of South African HIV-positive children. JSCiD. 2019; 39(2):135-9. https://doi.org/10.1111/scd.12353
2. Possagno L-P, Franco A, Paranhos L-R and Grando L-J. Morphological analysis of the skeletal development in lateral cephalometric radiographs of HIV-infected children ongoing Highly Active Antiretroviral Therapy. JMO Patologia Oral y Cirugia Bucal. 2018; 23(6):e691. https://doi.org/10.4317/medoral.22610
3. Kapila A, Chaudhary S, Sharma R, Vashist H, Sisodia S, Gupta A, *et al.* A review on: Hiv aids. IJoP. 2016; 4(3):69-73.
4. de Souza RB, da Silva Assuncao LR, Franco A, Zaroni FM, Holderbaum RM and Fernandes A. Dental age estimation in Brazilian HIV children using Willems' method. JFSI. 2015; 257:510.e1-e4. https://doi.org/10.1016/j.forsciint.2015.07.044
5. Altan HO, Altan A, Bilgic F, Sozer OA and Damlar I. The applicability of Willems' method for age estimation in southern Turkish children: A preliminary study. J of Forensic and Leg Med. 2016; 38:24-7. https://doi.org/10.1016/j.jflm.2015.11.015
6. Kermani M, Tabatabaei Yazdi F and Abed Haghighi M. Evaluation of the accuracy of Demirjian's method for estimating chronological age from dental age in Shiraz, Iran: Using geometric morphometrics method. JC Research ED. 2019; 5(3):191-8. https://doi.org/10.1002/cre2.169
7. Movahedian N, Abedi S and Memarpour M. Comparison of the Demirjian and root resorption methods to estimate dental age in radiographic images. JoDfC. 2018; 85(2):45-50.
8. Ardakani F, Bashardoust N and Sheikhha M. The accuracy of dental panoramic radiography as an indicator of chronological age in Iranian individuals. JFO. 2007; 25(2):30-5.
9. Sehrawat J and Singh M. Willems method of dental age estimation in children: A systematic review and meta-analysis. J of Forensic and Leg Med. 2017; 52:122-9. https://doi.org/10.1016/j.jflm.2017.08.017
10. Schmeling A, Reisinger W, Geserick G and Olze A. Age estimation of unaccompanied minors: Part I. General considerations. JFSI. 2006; 159:S61-S4. https://doi.org/10.1016/j.forsciint.2006.02.017
11. Eid R, Simi R, Friggi M and Fisberg M. Assessment of dental maturity of Brazilian children aged 6 to 14 years using Demirjian's method. IJ of PD. 2002; 12(6):423-8. https://doi.org/10.1046/j.1365-263X.2002.00403.x
12. Hegde R and Sood P. Dental maturity as an indicator of chronological age: radiographic evaluation of dental age in 6 to 13 years children of Belgaum using Demirjian methods. IJSPPD. 2002; 20(4):132-8.
13. Mohammed RB, Sanghvi P, Perumalla KK, Srinivasaraju D, Srinivas J, Kalyan US, *et al.* Accuracy of four dental age estimation methods in southern Indian children. JCDR. 2015; 9(1):HC01. https://doi.org/10.7860/JCDR/2015/10141.5495
14. Alqerban A, Alrashed M, Alaskar Z and Alqahtani K. Age estimation based on Willems method versus country specific model in Saudi Arabia children and adolescents. JBOH. 2021; 21(1):1-9. https://doi.org/10.1186/s12903-021-01707-9
15. Cherian JM, Thomas AM, Kapoor S and Kumar R. Dental age estimation using Willems method: A cross-sectional study on children in a North Indian city. JOMFP. 2020; 24(2):383. https://doi.org/10.4103/jomfp.JOMFP_299_19
16. Willems G, Van Olmen A, Spiessens B and Carels C. Dental age estimation in Belgian children: Demirjian's technique revisited. JFS. 2001; 46(4):893-5. https://doi.org/10.1520/JFS15064J

17. Wang J, Ji F, Zhai Y, Park H and Tao J. Is Willems method universal for age estimation: A systematic review and meta-analysis. J of Forensic and Leg Med. 2017; 52:130-6. https://doi.org/10.1016/j.jflm.2017.09.003
18. Pinchi V, Norelli G-A, Pradella F, Vitale G, Rugo D and Nieri M. Comparison of the applicability of four odontological methods for age estimation of the 14 years legal threshold in a sample of Italian adolescents. JFO. 2012; 30(2):17.
19. Javadinejad S, Sekhavati H and Ghafari R. A comparison of the accuracy of four age estimation methods based on panoramic radiography of developing teeth. J Dent Res Dent Clin Dent Prospects. 2015; 9(2):72-8. https://doi.org/10.15171/joddd.2015.015
20. Buonora S, Nogueira S, Pone MV, Aloe M, Oliveira RH and Hofer C. Growth parameters in HIV-vertically-infected adolescents on antiretroviral therapy in Rio de Janeiro, Brazil. A of TP. 2008; 28(1):59-64. https://doi.org/10.1179/146532808X270699
21. FernandesA, Cherubini K, Veeck EB, Grando LJ and Silva CL. Radiographic evaluation of the chronological development of permanent dentition in children infected with HIV. JCOI. 2007; 11(4):409-13. https://doi.org/10.1007/s00784-007-0124-1
22. Trigueiro M, Tedeschi-Oliveira S, Melani R and Ortega K. An assessment of adverse effects of antiretroviral therapy on the development of HIV positive children by observation of dental mineralization chronology. J of Oral Path and Med. 2010; 39(1):35-40. https://doi.org/10.1111/j.1600-0714.2009.00856.x
23. Kis HC, Gorurgoz C, Basol M, Canger EM and Oztas B. Evaluation of the Willems and Cameriere's dental age estimation methods in Turkish children - A modified version of Cameriere's method. JFSIR. 2020; 2:100105. https://doi.org/10.1016/j.fsir.2020.100105
24. Franco A, de Oliveira MN, Campos Vidigal MT, Blumenberg C, Pinheiro AA and Paranhos LR. Assessment of dental age estimation methods applied to Brazilian children: A systematic review and meta-analysis. JDMFR. 2021; 50(2):20200128. https://doi.org/10.1259/dmfr.20200128
25. El-Bakary AA, Hammad SM and Mohammed F. Dental age estimation in Egyptian children, comparison between two methods. J of Forensic and Leg Med. 2010; 17(7):363-7. https://doi.org/10.1016/j.jflm.2010.05.008
26. Movahedian N, Abedi S and Memarpour M. Comparison of the Demirjian and root resorption methods to estimate dental age in radiographic images. Journal of Dentistry for Children. 2018; 85(2):45-50.
27. Priya E. Applicability of Willem's Method of Dental Age Assessment in 14 Years Threshold Children in South India-A Pilot Study. JoFR. 2015; (S4):1. https://doi.org/10.4172/2157-7145.1000S4-002

How to cite this article: Paknahad M., Garmabi J., Heravi S. S. H., Pakshir H. and Omidi M. Dental Age Estimation in HIV-infected Children Using Willems Method. J Forensic Dent Sci 2021;13(3):131-137.

Access this article online	
Website: www.jfds.org	**Quick Response Code**