THREE DIFFERENT DENTAL AGE ESTIMATION TECHNIQUES IN NORTH INDIA: A COMPARATIVE EVALUATION

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Abstract:
Age estimation plays an indispensable role in forensic practice as it majorly involves civil or criminal matters. There are several methods utilized for age estimation on living as well as on deceased individuals which are based on dentition, ossification centers, lateral cephalograms, long or short bones. Among such diverse methods of age estimation, dental age estimation is a widely acceptable technique as it provides more reliable results. The present study aimed to evaluate and compare the applicability of the Demirjian, Willems, and London Atlas methods of dental age estimation in the growing children population of Northern part of the Indian population. The study includes 500 orthopantomagrams (OPG's) for radiographic evaluation of 500 subjects (249 males and 251 females) of age ranging 6 to 16 years. Dental age was calculated using Demirjian, Willems and London Atlas methods of each subject and compared with the chronological age of the subject. In order to determine whether there is a significant difference between the chronologic age and the estimated dental ages, one-way analysis of variance (ANOVA) and t tests were utilized. The Demirjian technique overestimated boys and girls in the studied population, whereas the Willems and London Atlas methods underestimated them. Comparatively more precise and dependable findings were obtained using the Willems method of dental age assessment in Northern part of the Indian population.

Keywords: Dental age estimation, Demirjian method, London Atlas method, Willems method

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INTRODUCTION:

Estimating the age of a child is significant in medical disciplines, such as orthodontics,forensic medicine, forensic anthropology, and forensic odontology as well as for the courtof law [1]. Majorly, there are certain cases where age estimation plays a pivotal role when achild is involved in heinous crime, sexual assault cases, illegal immigration, child abuse,child trafficking, underage marriages, pornography, civil as well as criminal affairs, massdisaster cases, poor maintenance of birth records and invalid documentation [2]. Such casesare frequently occurred in low regions of Northern part of India where medical records,birth records and dental records are not maintained. As per the aforesaid mentioned cases, forensic odontologistswork along with medical coroners to estimate the age of an individual for judicial purposes.Theageestimationmethodsarebasedonphysiologicalchanges,skeletaldevelopment and tooth maturation and development stages which could further assessed onradiological techniques, histological techniques, and clinical techniques. The age of anindividual could be assessed on the skeletal development of the hand and wrist, cervicalvertebrae, dental maturation, and secondary sexualcharacteristics [3,4].

The dental age can be evaluated with the aid of visual, radiographic, histological, and biochemical techniques. Under visual examination, various eruption phases of teeth are observed whereas, in histological examination, slides of teeth tissue are prepared and examined microscopically forthe purpose of dental age estimation. The radiographicmethodinvolvesexamination of different developmental phases of tooth, and this is the most acceptable methodwhich could be utilized on both living and dead [4].

The dental age estimation methods are classified on the basis of age group and developmental growth phase such as prenatal, neonatal, postnatal, children and adolescents, adults and senile [5]. It is correct to mentioned that India is a unique nation with diverse ethnicities; therefore, it is necessary to continually assess the applicability of various dental age estimation methodologies in various Indian ethnic groups [6].Although numerous research has been conducted to estimate dental age in various regions of India, it has been discovered that no similar assessment has been made to determine the applicability of dental age estimation methodologies in diverse ethnic groups in India [7]. Therefore, the purpose of the current study was to evaluate and compare the applicability of the Demirjian, Willems, and London Atlas dental age estimation methods in the growing children Indian population.

MATERIALS AND METHODS

The present paper involves retrospective study based on panoramic assessment of orthopantomograms (OPG's). 500 OPG's of North Indian children population were collected from variousprivatedentalhospitalsandclinics. All subjects thatwere initially selected endured a panoramic radiological examination between August2021, and November 2021 for diagnostic purpose. The inclusion and exclusion criteria's are discussed.

Inclusioncriteria

- Agerangingfrom 6to 16yearswhosebirthrecordisavailable were included.
- Subjects with good oral hygiene were included.
- Subjects with completemandibulardentition were included.

Exclusioncriteria

- Subjects undergoneorthodontictreatment were excluded.
- Subjects with missing ordistortion ofanymandibularteeth were excluded.
- Subjects with distorted digital resolution were excluded.

The subjects were distributed according to chronological age groups. The chronological age is determined by finding the difference between subject's birth date and date of radiograph when taken [8]. The Modified Demirjian comprehensive chart (DAEcc7) is used for estimating dental age ofanindividual.Thismethodinvolvestheanalysisof panoramic radiographs of the 7 lower leftpermanent teeth. The method is based on developmental stages of toothfrom the period of calcification to maturation, denoted withletters from A (the lowest maturation point) to H (the highest maturation point). Each stagefurther assigned a numerical value which was chosen and correlated according to Demirjiancomprehensive chart (2004) [9]. Each dental stage has been assigned in accordance withDemirjiancomprehensivechart depicted in figure 2andfurtherthesumofdentalagewascalculatedandcorrelated with maturation score [10].

The Demirjian approach and the Willems method of estimating dental age are very similar. For each of the seven left mandibular teeth, individually for

boys and girls, the calcification stages of tooth development were assessed according to Demirjian scoring criteria, and the scores of each calcification stage were directly stated in years. Using the reference tables provided by Willems, the scores of all seven teeth were combined to provide dental age in years [11]

Another study was published by AlQahatni in 2010 based on the tooth development & eruption of tooth. This atlas method has 21 age categories that is twenty eight weeks in-embryo-twenty three years which are founded on eruption & ejection of tooth. In this method, the stage identification is done with respect to the modified Moorrees stages S. J. AlQahtani, [12].

STATISTICAL ANALYSIS

Kappa statistics was used to assess the intraobserver and interobserver variability. Males and females underwent independent descriptive statistical analyses to determine the chronologic age mean, standard deviation, confidence interval, and predicted dental age. To assess the accuracy of each dental age estimation method, the mean absolute error (MAE) and mean error (ME) were computed for the estimated dental ages.

A one-way ANOVA test was used to determine whether there was a significant difference between the chronologic age and the estimated dental age for each male and female.

The significance between the chronologic age and the estimated dental age by the Demirjian, Willems, and London Atlas methods was assessed using the two-tailed t test. A p value of 0.05 or lower was deemed statistically significant. The SPSS software (22.0 version) was used to conduct the statistical analysis.

RESULTS

A total of 500 panoramic radiographs were analyzed, of which 251 are females and 240 are males with ages between 6 and 16 years from North Indian children population. The detaileddistribution of the studied growing children according to age and biological sex demonstratedinthe**Table1**.Thequantitativedatawas presented by calculating mean, standard deviation, and p-value according to the biological sexandageof growing children agedbetween6 to 16 years **Table 2 to Table 7.**

Chronological age (in years)	**Girls**		**Boys**		**Total**	
	(n)	**(%)**	**(n)**	**(%)**	**(n)**	**(%)**
6-6.9	16	6.42%	16	6.37%	32	6.40%
7-7.9	14	5.62%	14	5.57%	28	5.60%
8-8.9	24	9.63%	24	9.56%	48	9.60%
9-9.9	22	8.83%	22	8.76%	44	8.80%
10-10.9	26	10.44%	26	10.35%	52	10.04%
11-11.9	29	11.64%	29	11.55%	58	11.60%
12-12.9	24	9.63%	25	9.96%	49	9.80%
13-13.9	30	12.04%	30	11.95%	60	12.00%
14-14.9	25	10.04%	25	9.96%	50	10.00%
15-15.9	23	9.23%	23	9.16%	46	9.20%
16-16.9	16	6.42%	17	6.77%	33	6.60%
Total	249	100.00%	251	100.00%	500	100.00%

Table1. Distribution table according to the chronological age of subjects

Age Group (Yrs)	Gender	Mean ± SD CA	Mean ± SD EDA	Mean difference (EDA- CA)	p-value
6-6.9	M	6.21 ± 0.01	6.75 ± 0.12	0.54	0.016
7-7.9	M	7.01 ± 0.02	7.43 ± 0.11	0.42	0.012
8-8.9	M	8.20 ± 0.29	8.66 ± 0.32	0.46	0.014
9-9.9	M	9.32 ± 0.21	9.81 ± 0.21	0.49	0.015
10-10.9	M	10.14 ± 0.28	10.61 ± 0.29	0.47	0.016
11-11.9	M	11.25 ± 0.00	11.07 ± 0.01	-0.18	0
12-12.9	M	12.49 ± 0.00	12.90 ± 0.36	0.41	0.012
13-13.9	M	13.12 ± 0.00	13.52 ± 0.12	0.4	0.013
14-14.9	M	14.12 ± 0.00	14.22 ± 0.00	0.1	0.02
15-15.9	M	15.12 ± 0.02	15.18 ± 0.00	0.06	0.018
16-16.9	M	16.18 ± 0.06	16.12 ± 0.20	-0.06	0.012

Table 2. Correlation between Demirjian dental age and chronological age among males

Age Group (Yrs)	Gender	Mean ± SD CA	Mean ± SD EDA	Mean difference (EDA- CA)	p-value
6-6.9	F	6.25 ± 0.01	7.02 ± 0.12	0.77	0.032
7-7.9	F	7.02 ± 0.02	7.36 ± 0.11	0.34	0.041
8-8.9	F	8.05 ± 0.24	8.45 ± 0.20	0.4	0.012
9-9.9	F	9.95 ± 0.21	9.95 ± 0.21	0	0.012
10-10.9	F	10.92 ± 0.29	10.92 ± 0.29	0	0.017
11-11.9	F	11.05 ± 0.00	11.36 ±0.28	0.31	0.031
12-12.9	F	12.36 ± 0.01	12.36 ± 0.21	0	0.041
13-13.9	F	13.00 ± 0.00	13.45 ± 0.20	0.45	0.018
14-14.9	F	14.26 ± 0.00	14.22 ± 0.00	-0.04	0.012
15-15.9	F	15.38 ± 0.02	15.18 ± 0.00	-0.2	0.018
16-16.9	F	16.19 ± 0.06	16.12 ± 0.20	-0.07	0.012

Table 3. Correlation between Demirjian dental age and chronological age among males

Age group	Sex	N	CA		DA		DA-CA		95% CI of DA-CA		t-value	P value
			Mean	SD	Mean	SD	Mean	SD	Lower	Upper		
6-6.9	MALE	16	7.12	0.52	7.81	1.86	0.69	1.34	-0.3	1.33	-1.21	0.92
	Female	16	7.15	0.42	7.82	1.42	0.67	1	-0.66	0.62	0.08	0.33
	Total	32	7.18	0.5	7.76	1.62	0.58	1.12	-0.32	0.23	-0.31	0.25
7-7.9	Male	14	9.32	0.31	9.98	1.62	0.66	1.31	-0.49	0.02	1.17	0.04*
	Female	14	9.25	0.31	9.83	1.72	0.58	1.41	-0.55	0.38	0.21	0.75
	Total	28	9.28	0.32	9.86	1.73	0.58	1.41	-0.48	0.76	1.97	0.78
8-8.9	Male	24	10.12	0.67	10.65	1.37	0.53	0.7	-0.52	1.61	0.21	0.72
	Female	24	10.1	0.52	10.43	1.54	0.33	1.02	-0.16	0.79	1.7	0.51
	Total	48	10.08	0.34	10.55	1.82	0.47	1.48	-0.66	0.22	2.14	0.8
9-9.9	Male	22	13.18	0.47	10.28	1.74	-2.9	1.27	-0.08	0.18	0.76	0.14*
	Female	22	14.1	0.46	14.12	1.89	0.02	1.43	-0.1	0.15	5.17	0.00*
	Total	44	13.92	0.62	14.33	1.62	0.41	1	-0.15	1.58	4.41	0.33
10-10.9	Male	26	14.87	0.52	15.12	2.9	0.25	2.38	-0.69	2.14	3.89	0.23
	Female	26	14.92	0.59	15.21	2.91	0.29	2.32	-0.23	1.39	4.12	0.992
	Total	52	15.11	0.61	15.11	2.89	0	2.28	-0.23	2.12	3.78	0.811
11-11.9	Male	29	11.12	0.67	10.65	1.37	0.53	0.7	-0.52	1.61	0.21	0.72
	Female	29	11.31	1.02	10.43	1.54	0.33	1.02	-0.16	0.79	1.7	0.51
	Total	58	11.51	0.34	10.55	1.82	0.47	1.48	-0.66	0.22	2.14	0.8
12-12.9	Male	24	12.35	0.72	10.32	1.21	0.52	0.7	-0.52	1.61	0.21	0.52
	Female	25	12.41	0.32	10.44	1.20	0.55	1.01	-0.46	0.79	1.7	0.44
	Total	49	12.22	0.44	10.58	1.35	0.42	1.44	-0.36	0.22	2.14	055
13-13.9	Male	30	13.32	0.31	11.98	1.62	0.66	1.31	-0.49	0.02	1.17	0.03*
	Female	30	13.25	0.31	11.83	1.72	0.58	1.41	-0.55	0.38	0.21	0.75
	Total	60	13.28	0.32	11.86	1.73	0.58	1.41	-0.48	0.76	1.97	0.74
14-14.9	Male	25	14.87	0.52	15.12	2.9	0.25	2.38	-0.69	2.14	3.89	0.23
	Female	25	14.92	0.59	15.21	2.91	0.29	2.32	-0.23	1.39	4.12	0.99
	Total	50	14.20	0.61	15.11	2.89	0	2.28	-0.23	2.12	3.78	0.81
15-15.9	Male	23	15.22	0.52	16.07	2.9	0.25	2.38	-0.69	2.14	3.89	0.23
	Female	23	15.90	0.59	16.00	2.91	0.29	2.32	-0.23	1.39	4.12	0.82
	Total	46	15.44	0.61	16.01	2.89	0.22	2.28	-0.23	2.12	3.78	0.81
16-16.9	Male	16	16.27	0.52	15.12	0.19	0.25	2.38	-0.69	2.14	3.89	0.23
	Female	17	16.29	0.59	15.21	0.25	0.29	2.32	-0.23	1.39	4.12	0.90
	Total	33	16.10	0.61	15.11	0.28	0.18	2.28	-0.23	2.12	3.78	0.88

Table 4. Correlation between Willems dental age and chronological age among males and females

t-Test: Paired Two Sample for Means		
	Dental age(in years)	*Chronological age (in years)*
Mean	12.97457627	13.50847458
Variance	5.908825248	4.805961426
Observations	251	251
Pearson Correlation	0.921328304	
Hypothesized Mean Difference	0	
df	58	
t Stat	-4.333912812	
P(T<=t) one-tail	2.9495E-05	
t Critical one-tail	1.671552762	
P(T<=t) two-tail	5.89901E-05	
t Critical two-tail	2.001717484	

Table 5: Paired t-test for London Atlas method and chronological age among females

t-Test: Paired Two Sample for Means		
	Dental age (in years)	*Chronological age (in years)*
Mean	12.21111111	13.02222222
Variance	4.801010101	4.976767677
Observations	249	249
Pearson Correlation	0.9312455	
Hypothesized Mean Difference	0	
df	44	
t Stat	-6.628897258	
P(T<=t) one-tail	2.00436E-08	
t Critical one-tail	1.680229977	
P(T<=t) two-tail	4.00872E-08	
t Critical two-tail	2.015367574	

Table 6: Paired t-test for London Atlas method and chronological age among males

The comparison of the changes between chronological age and dental age were calculatedaccordingtothesubject'sbiologicalsexwh ichshows thattheallocationofthevariations was nonparametric in both girls and boys group based on theShapiro–Wilktest(p<0.05).

4. DISCUSSION

Dental age estimation remains important because it is probably the safest and simplestmethod for assessing the age of a child or of a young adult [13]. Dental age assessmentusingmineralizationstagingmethodis notonlyusefulinpediatricdentistryandorthodonti csbutcanbeusedbyimmigrationservicesforintern ationaladoptionswhenabirth certificate is not available orwhen the date of birth is not known and cannot bedetermined [14]. It can also be used for identifying victims of natural disasters and for othercircumstances when an individual's date of birthis unknown [15]. Determination of a method that can accurately assess theageisconsidered as an important factor which can be globally applicable. Dental age can be determined by morphological, biochemical, and radiological methods. Morphological methods for dental age estimation are generally derived from themethod originally conceived by Gustafson and involve the ex vivo microscopic analysisof extracted teeth [16]. Morphological methods bring up major moral issues when it comestotheirapplicationonlivingindividuals.Atb est,theycouldbeusedpostmortem,buteventhen, ethical, religious, or cultural issues may arise [17]. Biochemical methods for dental ageassessmentarebasedontheanalysisofthelevelo fD-asparticacidinenamel, dentin,andcement, which increases with age [18]. The biochemical method proposed by Ritz et al., 1995 allows a biopsy to be performed on the dentin, thus excluding the need for toothextraction in order to identify the age of a living person [19]. Hence, numerous radiographic methodsarenon-intrusive tothedentalstructure.Throughthesemethods,dent alagecan be estimated in prenatal, neonatal, postnatal, in children and adolescents, and in theadult population [20]. Although there are multiple methods of determining dental agebased on the radiological examination, such as the Nolla, Cameriere or Willems method, oneofthemostwidelyusedandpopularmethodsisth eDemirjian method[21].According to ethnic variations, the approaches for estimating dental age provide population-specific models for precise dental age estimation. Interesting enough, the results of the present study's dental age estimation using the Demirjian, Willems, and London Atlas methods were comparable for India's populations. The Demirjian method, Willems method and London Atlas method were also assessed on various Indian ethnic populations such as SouthIndian children population, Belgaum population of Karnataka, Davangere, Central Indians:Indore, Faridabad, Lucknow, Navi Mumbai and Gujarati populationTheoverestimationof0.04y(15d)observe din girls whereas overestimation of 0.14y (51d) observed in boys [22]. The similar results ofoverestimationwerealsofoundinDevangerechildr enpopulation[23].Moreover,theoverestimation results were also observed in Central Indian children population where 1.97foundingirlsand1.34mfoundinboys[24].

CONCLUSION:

The analysis of the Demirjian, Willemsand London Atlas methods revealed no discernible differences in the Indian population's ethnic composition. The current study stated that the Willems method of dental age assessment is accurate for both sexes in the populations of India's northern region.Furthermore, new standards need to be implemented to save laborious time forestimating dental age. Thus, also to check the limitation of the

study large number of samplesizeneed to takeinto consideration.

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