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Accuracy of Oro-cervical radiographic indexes in determining the chronological age- A digital radiographic study

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Abstract

Background: Forensic Odontology plays an important role using chronological age in personal identification when one is not holding the identification documents (birth date proof) and estimation of age at death in mass disasters and natural calamities.

Objective: To estimate the chronological age using or cervical indexes, to compare the known chronological age with the estimated age values and to assess the accuracy of the indexes for chronological age estimation on Indian population.

Material and Methods: The study was carried out on 120 patients who had undergone clinical examination of oral cavity and maxillofacial structures and had class-I molar relationship. A digital panoramic radiograph and a lateral cephalogram were taken in all patients. 120 patients were divided into three groups according to their chronological age (CA) and each group (CAG) was allotted 40 subjects(40x3=120). CAG1=below 14 years, CAG2=14-18years, CAG3=above 18 years. Stage of each method was simplified as DM -A TO G=0 POINT, H=1 POINT; CVMS –I TO III=0 POINT, IV=1 POINT, V & VI=2 POINT; TMDS –A & B=0 POINT, C TO F=1 POINT, G & H= 2 POINT. The addition of the simplified scores generated two new Oro-cervical radiographic indexes as OCRSS-A, B, C and OCRSSWWT- A, B, C. The values were then compared with the known chronological age.

Results: When estimated age group was compared with known age, in maximum cases it was same except in a few subjects. A highly statistically significant correlation was found between chronological age CA and OCRSS (r^2 =.803 and $p<0.001$) and between OCRSS and CAG ($p<0.001$, r^2=0.766). A significant correlation was also found between chronological age and OCRSSWWT (r^2 =.852 and $p<0.001$) and between OCRSSWWT and CAG ($p<0.001$, r^2=0.867).

Conclusion: This study proves the accuracy of the indexes as the results show statistically significant

results when used to compare the known biological age with estimated chronological age group.

Keywords: Forensic odontology, cervical vertebrae, third molar, Demirjian's method

Introduction

A new science that has developed as a special entity in dentistry is Forensic Odontology. This field of dental sciences utilizes the power of knowledge of the dentist to serve the judicial system by estimating the age which is an important aspect of forensic research. In present crimeful state of world, especially in India, its use is increasing in both civil and criminal matters. It also helps in identification of age at death of a dead individual in mass disasters and natural calamities.[1] Age estimation also becomes of utmost importance when one is not holding the identification documents (birth date proof) and is produced in the court of law. In some societies it is also used to assess age of living persons for marriage and employment.[2]

Law in our country considers chronological age as one of the essential requirements for deciding the imputability.[3] According to the Indian law, 3 major chronological age groups are divided as follows- less than16 years, 16-18 years, more than 18 years to decide the immutability of a person. As per justice juvenile act 2015, the accused or defendant is dealt with differently in both the age groups (16 yrs and above and under 16 yrs).[4] Chronological age estimation becomes a ruling factor in such cases where the judicial system has to decide the punishment based on the age of the person who is in conflict with law (e.g., Delhi gang rape case of December, 2012.)

The most common methods used for the chronological age assessment is by estimating the biological age. Biological age, that is dental age and skeletal age, is estimated by using Demirjian's method and hand and wrist skeletal development atlas respectively.[5] Dental age can be assessed by observing the timing of eruption and the degree of mineralization of the developing teeth from radiographs.[6] Many authors have developed scoring methods in order to assess dental age using dental calcification stages of permanent teeth, including Demirjian, Nola, Goldstein, and Van der Linden. The most widely used dental maturity scaling system is the method developed by Demirjian in 1973 on a sample of French-Canadian children.[7] As it has better accuracy and feasibility, Demirjian's method (DM) combined with other methods have been used in this study.

In medico-legal cases, skeletal age (SA) is regarded as the most convincing estimate of age, using hand and wrist skeletal maturation atlas.[8] In recent years, cervical vertebrae maturation has been increasingly used for skeletal age estimation as is done on routine lateral cephalograms without any additional exposure.[9] Lamparski, in 1972, stated that the cervical vertebrae were as statistically and clinically reliable in assessing skeletal age as the hand-wrist technique.[10] A moderately high correlation between the two has been found in many studies.[11]

Third molar development is the third major tool for the dental age assessment as it is easy and time saving method.[12] It can be used to estimate chronological age in a wide age range as they have a long period of development.[15] Using these three different already validated methods, two new or cervical indices have been formed, Oro cervical radiographic simplified scores-OCRSS and Oro cervical radiographic simplified scores without wisdom tooth-OCRSSWWT to find out the correlation between CA and biological age in Italian population.[3]

There are not many studies conducted in literature to prove the validity of these new indices in India and also in other countries. So, this study aims at finding out the accuracy of these 2 new indices with radiographs on a larger sample size to estimate the exact chronological age group in short time period in Indian population.

Objectives

- To estimate age using a new radiographic index- Oro cervical radiographic simplified scores (OCRSS)
- To estimate age using another new radiographic index- Oro cervical radiographic simplified scores without wisdom tooth (OCRSSWWT)
- To compare the values of known chronological age with the estimated biological age
- To assess the accuracy of the indices for chronological age estimation on Indian population.

Source of data: Patients consulting the Department of Oral Medicine & Radiology, AECS Maruti College of Dental Sciences and Research Centre, Bangalore after obtaining the required informed consent.

Inclusion criteria: Patients with molar class-I relationship**,** All good quality radiographs**,** Patients with all third quadrant teeth present.

Exclusion criteria: Patients who have already received radiation exposure many times before**,** Patients with significant medically compromised conditions, pregnant females patients**,** Patients with congenital or acquired craniofacial abnormalities.

Methodology

A cross-sectional clinical study was carried out on 120 patients who had undergone clinical examination of oral cavity with the required armamentarium and maxillofacial structures and had class-I molar relationship. After taking a written informed consent and recording the original date of birth (using driving license or any other), a digital panoramic radiograph using an CS 8000C care stream software (KODAK) operating at 55-80 kVp/1-20 mA and exposure time of 15 seconds and a lateral cephalogram with exposure time of 0.5 seconds, were taken in all patients. 120 patients were divided into three groups according to their chronological age and each group was allotted 40 subjects -

- Group1:CAG1=below 14 years
- Group2:CAG2=14-18years
- Group 3:CAG3=above 18 years

On digital OPG, all third quadrant 8 teeth were observed using Demirjian's method.[5] Dental maturity and dental age was estimated with reference to radiological appearances of the 7 teeth on the left side of the mandible. Each tooth was rated according to development criteria (amount of dentinal deposit, shape change of pulp chamber etc.) rather than changes in size (fig.1). Eight stages, A to H were defined from the first appearance of calcified point to the closure of apex. Third molar was also examined and staged from A to H using Demirjian's method.[12]

On digital lateral cephalogram, C2 (2nd Cervical Vertebra), C3 (3rd Cervical Vertebra) and C4 (4th Cervical Vertebra) were examined and staged from CS-1(Cervical Stage 1) to CS-6 (Cervical Stage 6) based on the shape, height and appearance of a visible concavity at the lower border of second, third and fourth Cervical Vertebra. Concavity is said to be present when the distance between the middle lower border of vertebral body and line drawn from the posterior-inferior to anterio-inferior borders of the vertebral body is more than 1mm.[13]

According to Baccetti et al[14], these stages are (fig. 2)

Stage CS1

Lower border of all the cervical vertebrae is flat. The shape of C3 and C4 vertebrae is similar to a rectangular trapezium, there are minimum 2 or more years left to the beginning of maximum pubertal growth.

Stage CS2

A concavity appears on the lower border of C2 (over or equal to 0.8 mm), the lower border in C3 and C4 vertebrae is flat. The shape of C3 and C4 vertebrae is similar to a rectangular trapezium. There is about 1 year left to the beginning of maximum pubertal growth.

Stage CS3

The lower border of C3 vertebra becomes concave (the concavity on C2 is over or equal to 0.8 mm), the shape of C3 and C4 vertebrae stays without considerable changes. It is the beginning of maximum pubertal growth.

Stage CS4

All the vertebrae have a concavity on the lower border, the shapes of the vertebrae turn into a rectangle. It is the end of maximum pubertal growth.

Stage CS5

The concavity on the lower border and the shape of C3 and (or) C4 changes into a square. It has been about a year since maximum pubertal growth.

Stage CS6

There is a concavity on the lower borders and the proportion of the length of the borders of C3 or (and) C4 changes – the vertical borders become longer than the horizontal ones. There have been 2 years or more since maximum pubertal growth.

Stage of each method was simplified as follows [3]

- DM -A TO G=0 POINT H=1 POINT
- CVMS –I TO III=0 POINT IV=1 POINT V & VI=2 POINT
- TMDS –A & B=0 POINT C TO F=1 POINT G & H= 2 POINT

The addition of the simplified scores generated two new Oro-cervical radiographic indexes. First, the OCRSS (Oro Cervical Radiographic Simplified Score) was the result of addition of simplified scores of the three methods. Second, the OCRSSWWT (Oro Cervical Radiographic Simplified Score Without Wisdom Teeth) was the result of the addition of the simplified DM (Demirjian's Method) and CVM (Cervical Vertebral Maturation) scores.

- OCRSS (Oro Cervical Radiographic Simplified Score) [3]

Ø A. Sum of simplified scores 0-1: OCRSS A.

Ø B. Sum of simplified scores 2-4: OCRSS B

Ø C. Sum of simplified scores 5: OCRSS C.

- OCRSSWWT (Oro Cervical Radiographic Simplified Score Without Wisdom Teeth)[3]:

Ø Sum of simplified scores 0-1: OCRSSWWT A.

Ø Sum of simplified scores 2: OCRSSWWT B.

Ø Sum of simplified scores 3: OCRSSWWT C.

According to the study conducted by C Lajolo et al, scores obtained were inferred as a chronological age group-CAG, which were also used in our study as follows

Scores of A of both the indexes-OCRSS and OCRSSWWT-A were inferred as CAG-1=<14 yrs

Scores of B of both the indexes-OCRSS and OCRSSWWT-B were inferred as CAG-2=14-18 yrs

Scores of C of both the indexes-OCRSS and OCRSSWWT-C were inferred as CAG-3=>18 yrs

The known chronological age and estimated age groups were compared which had to be the same in order to prove the accuracy of these two indexes for age estimation. The results were tabulated and graphed as shown below.

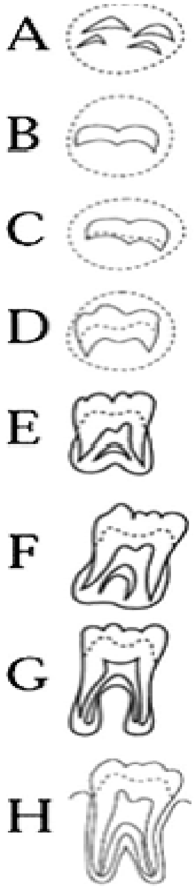

Figure 1: Dental stages according to Demirjian's method[5]

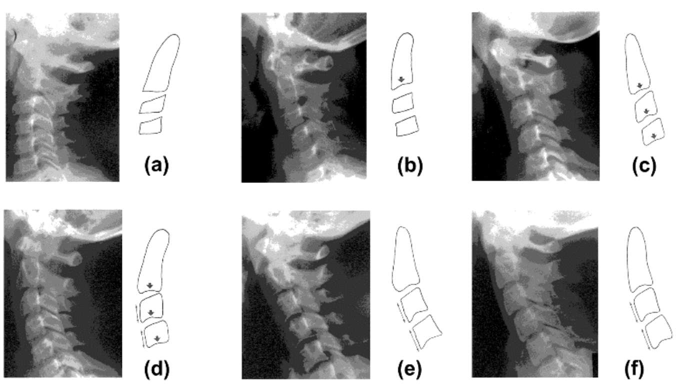

Figure 2: Cervical vertebral developmental stages, CVMS I to CVMS IV, proposed by Baccetti et al.[14]

Statistical analysis

Data was entered in to Microsoft® Excel and analyzed using R software (ver 3.3.1). Quantitative variables were summarized as mean & standard deviation; qualitative variables are summarized as proportions. Nominal variables were assessed using the Chi-Squared test and Fisher's exact test. Correlation between OCRSS or OCRSSWWT and CAGs or CA was analyzed using Pearson's correlation. A p-value of < 0.05 was considered to best statistically significant.

Results

The total sample consisted of 120 subjects whose orthopantomogram and lateral cephalogram each were taken and then examined. There were total of 120 patients who were divided in three chronological age group as-CAG 1, CAG 2 and CAG 3 with 40 subjects each according to their known chronological age distribution. Out of total 120 patients, CAG 1 had 21 (38.89%) males, 33 (61.11%) females, CAG 2 had 10 (38.46%) males and 16 (61.54%) females and CAG 3 had 11 (27.5%) males and 29 (72.5%) females shown in table 1. Mean chronological age for females in CAG1, CAG 2, and CAG 3 was found to be 12.61, 15.81, and 20.83 respectively. Mean chronological age for males in CAG1, CAG 2, and CAG 3 was found to be 11.86, 15.7, and 20.27 respectively as shown in table 4.

Oro-Cervical Radiographic Simplified Score (OCRSS)

40 individuals were assigned to group OCRSS A, out of which 20 (50%) each was males and females. 48 individuals were assigned to group OCRSS B, out of which 12 (25%) were males and 36 (75%) were females. 32 individuals were assigned to group OCRSS C, out of which 10 (31.25%) were males and 22 (68.75%) were females shown in table 2. Mean chronological age for females according to OCRSS in CAG1, CAG 2, and CAG 3 was found to be 11.75, 15.92 and 21.14 respectively. Mean chronological age for males in CAG1, CAG 2, and CAG 3 was found to be 11.75, 15.92 and 20.3 respectively as shown in table 5. A significant correlation was found between chronological age and OCRSS as shown in table 9 (r^2 =.803 and $p<0.001$). The

correlation remained significant when the sample was stratified by sex. For males, there was a significant correlation between the OCRSS groups and CA (r^2= .872, p < 0.001) and for females, significant correlation was found between OCRSS and CA (r^2=.766, p<0.001). There was a significant correlation was found between OCRSS and CAG (p<0.001, r^2=0.766) with significant correlation when the sample was stratified by sex as the values came out to be for females and males -p<0.001, r^2=0.684 and p<0.001, r^2=0.933 respectively shown in table 10.

Oro-Cervical Radiographic Simplified Score without Wisdom Teeth (OCRSSWWT)

45 individuals were assigned to group OCRSSWWT A, out of which 21 (46.67%) were males and 24 (53.33%) were females. 35 individuals were assigned to group OCRSSWWT B, out of which 10 (28.57%) were males and 25 (71.43%) were females. 40 individuals were assigned to group OCRSSWWT C, out of which 11 (27.5%) were males and 29 (72.5%) were females shown in table 3. Mean chronological age for females according to OCRSSWWT in CAG1, CAG 2, and CAG 3 was found to be 12.13, 15.12 and 20.83 respectively. Mean chronological age for males in CAG1, CAG 2, and CAG 3 was found to be 11.95, 15.5 and 20.27 respectively as shown in table 6. A significant correlation was found between chronological age and OCRSSWWT as shown in table 11 (r^2 =.852 and p<0.001). The correlation remained significant when the sample was stratified by sex. For males, there was a significant correlation between the OCRSSWWT groups and CA (r^2= .870, p < 0.001) and for females, significant correlation was found between OCRSSWWT and CA (r^2=.837, p<0.001). There was a significant correlation was found between OCRSSWWT and CAG (p<0.001, r^2=0.867) with significant correlation when the sample was stratified by sex as the values came out to be for females and males -p<0.001, r^2=0.839 and p<0.001, r^2=0.933 respectively shown in table 12.

Table 1: Distribution of Study Subjects according to Gender & Chronological age groups

CAG	Male	Female	Total
CAG-1 (8 - 14 yrs)	21 (38.89)	33 (61.11)	54 (100)
CAG-2 (15-18 yrs)	10 (38.46)	16 (61.54)	26 (100)
CAG-3 (≥ 19 yrs)	11 (27.5)	29 (72.5)	40 (100)
Total	42 (35)	78 (65)	120 (100)

Table 2: Distribution of Study Subjects according to Gender &OCRSS groups

OCRSS	Male	Female	Total
OCRSS A	20 (50)	20 (50)	40 (100)
OCRSS B	12 (25)	36 (75)	48 (100)
OCRSS C	10 (31.25)	22 (68.75)	32 (100)
Total	42 (35)	78 (65)	120 (100)

Table 3: Distribution of Study Subjects according to Gender & OCRSSWWT groups

OCRSSWWTT	Male	Female	Total
OCRSSWWT A	21 (46.67)	24 (53.33)	45 (100)
OCRSSWWT B	10 (28.57)	25 (71.43)	35 (100)
OCRSSWWT C	11 (27.5)	29 (72.5)	40 (100)
Total	42 (35)	78 (65)	120 (100)

Table 4: Descriptive statistics for chronological age according to Gender & CAG

		N	Mean	SD	Min	Max	95% Confidence Interval	
							Lower	Upper
CAG-1 (9- 14 yrs)	Male	21	11.86	1.39	9	14	11.26	12.46
	Female	33	12.61	1.44	10	14	12.11	13.11
	Total	54	12.32	1.45	9	14	11.92	12.72
CAG-2 (15-18 yrs)	Male	10	15.70	1.06	15	18	15.02	16.38
	Female	16	15.81	1.11	15	18	15.25	16.37
	Total	26	15.77	1.07	15	18	15.35	16.19
CAG-3 (≥ 19 yrs)	Male	11	20.27	0.91	19	22	19.73	20.81
	Female	29	20.83	1.69	19	24	20.21	21.45
	Total	40	20.68	1.53	19	24	20.2	21.16

Table 5: Descriptive statistics for chronological age according to Gender & OCRSS groups

		N	Mean	SD	Min	Max	95% Confidence Interval	
							Lower	Upper
OCRSS-A	Male	20	11.75	1.33	9	13	11.15	12.35
	Female	20	11.75	1.21	10	14	11.21	12.29
	Total	40	11.75	1.26	9	14	11.35	12.15
OCRSS-B	Male	12	15.92	1.68	14	20	14.96	16.88
	Female	36	15.92	2.30	13	21	15.16	16.68
	Total	48	15.92	2.14	13	21	15.3	16.54
OCRSS-C	Male	10	20.30	0.95	19	22	19.7	20.9
	Female	22	21.14	1.78	19	24	20.38	21.9
	Total	32	20.88	1.60	19	24	20.32	21.44

Table 6: Descriptive statistics for chronological age according to Gender & OCRSSWWT groups

		N	Mean	SD	Min	Max	95% Confidence Interval	
							Lower	Upper
Ocrsswwt-a	Male	21	11.95	1.60	9	16	11.25	12.65
	Female	24	12.13	1.42	10	15	11.55	12.71
	Total	45	12.04	1.49	9	16	11.6	12.48
Ocrsswwt-b	Male	10	15.50	1.18	14	18	14.76	16.24
	Female	25	15.12	1.27	14	18	14.62	15.62
	Total	35	15.23	1.24	14	18	14.81	15.65
Ocrsswwt-c	Male	11	20.27	0.91	19	22	19.73	20.81
	Female	29	20.83	1.69	19	24	20.21	21.45
	Total	40	20.68	1.53	19	24	20.2	21.16

Table 7: Distribution of study subjects according to CAG& OCRSS groups

			OCRSS A	OCRSS B	OCRSS C	Total	Fisher's exact test
CAG	1	9 - 14 yrs	40 (74.07)	14 (25.93)	0 (0)	54 (100)	p<0.001
	2	15-18 yrs	0 (0)	26 (100)	0 (0)	26 (100)	(Significant)
	3	≥ 19 yrs	0 (0)	8 (20)	32 (80)	40 (100)	
		Total	40 (33.33)	48 (40)	32 (26.67)	120 (100)	

			OCRSS A	OCRSS B	OCRSS C	Total	Fisher's exact test
CAG Male	1	9 - 14 yrs	20 (95.24)	1 (4.76)	0 (0)	21 (100)	p<0.001
	2	15-18 yrs	0 (0)	10 (100)	0 (0)	10 (100)	(Significant)
	3	≥ 19 yrs	0 (0)	1 (9.09)	10 (90.91)	11 (100)	
		Total	20 (47.62)	12 (28.57)	10 (23.81)	42 (100)	

			OCRSS A	OCRSS B	OCRSS C	Total	Fisher's exact test
CAG Female	1	9 - 14 yrs	20 (60.61)	13 (39.39)	0 (0)	33 (100)	p<0.001
	2	15-18 yrs	0 (0)	16 (100)	0 (0)	16 (100)	(Significant)
	3	≥ 19 yrs	0 (0)	7 (24.14)	22 (75.86)	29 (100)	
		Total	20 (25.64)	36 (46.15)	22 (28.21)	78 (100)	

Table 8: Distribution of study subjects according to CAG & OCRSSWWT groups

			OCRSSWWT A	OCRSSWWT B	OCRSSWWT C	Total	Fisher's exact test
CAG	1	9 - 14 yrs	43 (79.63)	11 (20.37)	0 (0)	54 (100)	p<0.001
	2	15-18 yrs	2 (7.69)	24 (92.31)	0 (0)	26 (100)	(Significant)
	3	≥ 19 yrs	0 (0)	0 (0)	40 (100)	40 (100)	
		Total	45 (37.5)	35 (29.17)	40 (33.33)	120 (100)	

			OCRSSWWT A	OCRSSWWT B	OCRSSWWT C	Total	Fisher's exact test
CAG Male	1	9- 14 yrs	20 (95.24)	1 (4.76)	0 (0)	21 (100)	p<0.001
	2	15-18 yrs	1 (10)	9 (90)	0 (0)	10 (100)	(Significant)
	3	≥ 19 yrs	0 (0)	0 (0)	11 (100)	11 (100)	
		Total	21 (50)	10 (23.81)	11 (26.19)	42 (100)	

			OCRSSWWT A	OCRSSWWT B	OCRSSWWT C	Total	Fisher's exact test
CAG Female	1	9 - 14 yrs	23 (69.7)	10 (30.3)	0 (0)	33 (100)	p<0.001
	2	15-18 yrs	1 (6.25)	15 (93.75)	0 (0)	16 (100)	(Significant)
	3	≥ 19 yrs	0 (0)	0 (0)	29 (100)	29 (100)	
		Total	24 (30.77)	25 (32.05)	29 (37.18)	78 (100)	

Table 9: Correlation between OCRSS groups & Chronological age

	R	r^2	p value
Male	0.934	0.872	p<0.001
Female	0.875	0.766	p<0.001
Total	0.896	0.803	p<0.001

Table 10: Correlation between OCRSS groups &CAG

	R	r^2	p value
Male	0.966	0.933	p<0.001
Female	0.827	0.684	p<0.001
Total	0.875	0.766	p<0.001

Table 11: Correlation between OCRSSWWT groups & Chronological age

	R	r^2	p value
Male	0.933	0.870	p<0.001
Female	0.915	0.837	p<0.001
Total	0.923	0.852	p<0.001

Table 12: Correlation between OCRSSWWT groups &CAG

	R	r^2	p value
Male	0.966	0.933	p<0.001
Female	0.916	0.839	p<0.001
Total	0.931	0.867	p<0.001

Discussion

Radiology plays a very important role in human age determination as radiological images are utilized in the process of age estimation. The radiological method has certain advantages over histological and biochemical methods as other methods require either extraction or preparation of microscopic sections of at least one tooth from each individual. Therefore, can't be used in living subjects and in cases where it is not acceptable to extract teeth for religious or scientific reasons.[16]

On the contrary, the radiographic method is a simple, quick, economic, non-mutilating and non-invasive method of age identification.[17] The hand and wrist skeletal development atlas[18] and the Cervical Vertebral Maturation method[14] for skeletal age calculation are well known radiographic procedures to assess the chronological age. For the dental age estimation, it is well-known that DM can produce reliable and precise information in individuals up to 14 years old; whereas, for individuals older than 14 years,

the third molars remain the only anatomical structure that can provide information for age calculation in an orthopantomogram.[19]The Demirjian method was found to be the most accurate in terms of the evaluation of mineralization of the third molar for the purpose of age determination.[5] Third molar is considered as an ideal developmental marker as it has been found that there is an association between the chronological age and its formation. However, Mincer et al did not support the use of the third molar as an age indicator. This could be because third molar is the most variable tooth in the dentition as regards size, time of formation and time of eruption.[21] According to a study done by Anderson DL et al, there was high variability in age of third molar mineralization in females and it was less in both sexes at late stages of root formation.[22]

Our study included the use of all three radiographic methods in the form of indexes which have not been used on Indian population before. The first score, OCRSS, assessed the accuracy of the correlation between a new Oro-cervical index that combines all 3 radiographic methods and CA.

The second one, OCRSSWWT, assessed the accuracy of the correlation when TMD could not be used (i.e., when the third molars were missing). The importance of results of indexes and their significance in practical application is discussed below one by one.

In our study, first index used was OCRSS and a highly statistically significant correlation was found between chronological age CA and OCRSS (r^2 =.803 and p<0.001) and between OCRSS and CAG (p<0.001, r^2=0.766). Out of 120 subjects total of 40 were assigned to OCRSS-A who all belonged to CAG1 as shown in table 7.

The other conclusions drawn from the study for this index were 1. Only one subject from the CAG1 was falling in the OCRSS-B group whereas all others were belonging to OCRSS-A. This indicates older age group for that subject. 2. No subject in CAG2 was identified as belonging to the group other than OCRSS-B. 3. Eight subjects from CAG3 were identified to fall in OCRSS-B rather than in OCRSS-C. The above results tend to show that OCRSS has a high reliability for the younger age groups whereas in oldest age group it appears to underestimate the age. The reason for this could be because of the reliability of Demirjian's Method for younger age group.[5] Also when the sample was stratified with sex the correlation was significant and that one subject, as discussed in point no.1, was a female. This could be because of the hormonal factors that could have resulted in earlier maturation. DM use for the age estimation resulted in overestimation of age in a study done on south Indian children by Koshy S and Tandon S.[20]

The second index used was OCRSSWWT. A significant correlation was found between chronological age and OCRSSWWT as shown in table 11 (r^2 =.852 and p<0.001) and between OCRSSWWT and CAG (p<0.001, r^2=0.867). Out of 120 subjects, 45 were assigned to OCRSS-A, 43 belonged to CAG1 and 2 belonged to CAG2 as shown in table 8. About the reliability of index the following conclusions can be drawn. 1. All 20 CAG 1 individuals were identified correctly as they all belonged to OCRSSWWT-A, thus suggesting strong reliability when analyzing younger individuals. 2. Four subjects from CAG2 (three females and one male) were identified incorrectly belonging to OCRSSWWT-A. This suggests the underestimation of age with the index for this age group.3. All subjects in CAG3 were correctly assigned to OCRSSWWT-C.

These two indexes when taken together appear to be simple, easy and fast to estimate the age group of the subject. However, overestimation of age with OCRSS - A and OCRSSWWT-A in youngest age groups and underestimation by OCRSS-C for CAG3 and by OCRSSWWT-B for CAG2 must be considered. OCRSS appears to be more reliable as compared to OCRSSWWT.

The variation in growth of the individuals can influence the anatomical and changes from childhood to adulthood. This could be the reason for the variability seen in results although the results are statistically highly significant. The reliability of these indexes also varies according to different races as age determination within individuals from the same Country can be highly variable up to 14 months of age, mainly due to racial differences.[19] Also,

nutritional differences and radiological findings can contribute to high variability which should not be forgotten to be considered. Moreover, our study gives a chronological age group rather than an exact chronological age of the subject. Observational errors should also be considered. We consider these above factors as limitations to our study.

Conclusion

This study represents the first research on the applicability of the method proposed by Lajolo et al.[3] in Indians, using a large sample. In conclusion, the highly statistically significant results are obtained which prove

OCRSS and OCRSSWWT can be used for the chronological age group estimation on Indian population to find out the immutability of the person with the least number of radiographs. The indexes show significant results when used to compare the known biological age with estimated chronological age group. These Oro cervical radiographic indexes can be used in a population while considering the limitations of their use. In our study, OCRSS appears to be more reliable for CAG2 and OCRSSWWT more reliable for CAG3.

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