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Analyzing the Interobserver Variability in Stages of Tooth Development with Orthopantomogram (OPG)

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Abstract ***The development of teeth in human body follows a definitive chronological sequence. The different stages of formation of teeth have been used to evaluate the maturity and age of an individual. In dentistry, this estimation has been widely used to assess the growth for planning treatment. The legal system also uses this chronology to estimate the age of an individual, as there are various laws governing the adult and the juvenile in different countries, and dental age estimation has been widely used standard of age estimation when there are no legal records of age available. The aim was to study the agreement of the scoring pattern between different individuals while using the most popular techniques of Demirjian and Nollas for scoring for the age of an individual. To assess the accuracy and correlation of agreement between individuals for the various stages of tooth development as proposed by Demirjians and Nolla.To propose a system that is easily reproducible of the two.To assess the need for automation of the scoring system to eliminate human judgemental errors. 50 doctors were asked to score the OPG of 6 patients for the demirjians and nollas age assessment. They were assessed for agreement of various stages with the result closest to the age at the time of radiograph. The results were tabulated and tested statistically using interclass correlation co efficient and their statistical significance assessed. Both the tests had good correlation among clinicians for teeth 1st premolar and 1st molar. Rest of the teeth has mixed results. Demirjians had better correlation co efficient than the nollas technique. The differences in identification of the stages was statistically significant. Demirjians showed more agreement between the practitioners than Nollas but has statistically significant differences. This precludes the need for an automated system which will ensure reproducible scoring and age assessment.***

Index Terms**: Cronbach's Alpha ,Demirjian , Nollas and variability.**

I. INTRODUCTION

In the last decade there has been widespread influx of immigrants into the developed countries from the conflict zones. One group of these immigrants is the unaccompanied minors. The organizations that provide services to these asylum seekers need the ages of these immigrants assessed to enable them to benefit from various government schemes for health and educational needs [1]. Errors in age assessment at this level can affect the individual as they may be required to stay in a higher or lower schooling level if there is an error in the assessment method. [1]

Many methods of age assessment are being carried out. Some are physical examinations that are carried out with pediatricians and others involve radiographic [2] and dental examinations [3] with Radiologist and Pediatric dentists respectively.

Radiological dental examination has few established techniques such as the Demirjians technique, the Nolla's technique [4]and the Carmeriere's [5] technique. These techniques have been used and modified around the world for accuracy and precision age in various ethenic groups.[6-13]

In all these dental radiographic techniques , the stage of tooth formation is the key to estimate the age of the individual. The calculation of the age therefore is fully dependent on identification of the right stage of development of teeth. Demirjian in his article has stated the different stages of tooth development and has numbered it A-H. The identification of these stages can change from one observer to the other creating errors in age assessment when done by one individual to another. Hence a study was planned to assess the severity of such errors so as to perceive the need for development of an error free assessment technique using advanced image processing technology.

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II. MATERIALS AND METHOD

The study was done using six randomly selected digital panoramic radiographs with known date of birth of the children, both gender males and females in mixed dentition period (7-15) years. Fifty practicing dentist were requested to score and estimate the age of the above children using Demirijian and Nolla stage of tooth development.

Fifty practicing dentist, were requested to score and estimate the age for 6 OPG which had the known date of birth and age at the time of X-rays. Among fifty entries only forty one has complete entries. Their options of stage of tooth development were checked with one of the entry among the forty one which gives the result closest to the age at the time of radiograph.The stages identified by the 40 dentist were then assessed for agreement for each tooth and the agreement was statistically analyzed for significance.

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Method	Tooth	N	Intraclass correlation coefficient (Cronbach's Alpha)	p value	Confidence Interval (CI)
Nollas	Central Incisor	40	0.272 (Poor agreement)	0.084	-0.143 to 0.572
Demirjians			0.939 (Good agreement)	0.000	0.903 to 0.964

TABLE 1: The central incisors had good agreement in the Demirjians classification with a Inter class correlation of 0.939 and was statistically significant at P=0.000. where has Nollas had poor agreement.

Method	Tooth	N	Intraclass correlation coefficient (Cronbach's Alpha)	p value	Confidence Interval (CI)
Nollas	Lateral Incisor	40	0.366 (Poor agreement)	0.024	0.005 to 0.628
Demirjians			0.660 (Moderate agreement)	0.000	0.380 to 0.840

TABLE 2: The agreement pattern in the Lateral incisors was lesser than Centrals and it was moderate for Demirjians (ICC 0.660)nand Poor for Nollas (ICC 0.366).

Method	Tooth	N	Intraclass correlation coefficient (Cronbach's Alpha)	p value	Confidence Interval (CI)
Nollas	Canine	40	0.533 (Moderate agreement)	0.000	0.266 to 0.726
Demirjians			0.117 (Poor agreement)	0.287	-0.387 to 0.481

TABLE 3: In the Canine teeth Nollas classification showed moderate agreement (ICC 0.533) and very poor agreement for Demirjians (ICC 0.117)

Method	Tooth	N	Intraclass correlation coefficient (Cronbach's Alpha)	p value	Confidence Interval (CI)
Nollas	1st premolar	40	0.938 (Good agreement)	0.000	0.902 to 0.963
Demirjians			0.992 (Good agreement)	0.000	0.877 to 0.984

TABLE 4: The first premolar showed good agreement for both Nollas (ICC 0.938) and Demirjians (0.992)

Method	Tooth	N	Intraclass correlation coefficient (Cronbach's Alpha)	p value	Confidence Interval (CI)
Nollas	2nd premolar	40	0.163 (poor agreement)	0.216	-0.314 to 0.509
Demirjians			0.540 (Moderate agreement)	0.000	0.277 to 0.730

TABLE 5: In the second premolar the Nollas with an ICC 0.163 has poor agreement and the demirjian has ICC of 0.540.

Method	Tooth	N	Intraclass correlation coefficient (Cronbach's Alpha)	p value	Confidence Interval (CI)
Nollas	1st Molar	40	0.920 (Good agreement)	0.000	0.874 to 0.953
Demirjians			0.925 (Good agreement)	0.000	0.882 to 0.956

TABLE 6: The First molar has good agreement in both with an ICC of 0.920 and 0.925 in nollas and demerjians technique respectively.

Method	Tooth	N	Intraclass correlation coefficient (Cronbach's Alpha)	p value	Confidence Interval (CI)
Nollas	2nd Molar	40	0.619 (Moderate agreement)	0.000	0.402 to 0.776
Demirjians			0.759 (Good agreement)	0.000	0.622 to 0.859

TABLE 7: On evaluating the stage identification in the 2nd molars, there was moderate agreement in Nolla's (ICC 0.619) and Good agreement for demirjians (ICC 0.759)

Method	Tooth	N	Intraclass correlation coefficient (Cronbach's Alpha)	p value	Confidence Interval (CI)
Nollas	3rd Molar	40	0.259 (Poor agreement)	0.097	-0.164 to 0.565

TABLE 8: On evaluating the stage identification in the 3rd molars, there was poor agreement in Nolla's (ICC 0.259)

For all intraclass reliability test has been done. Two- way mixed model, K raters type and consistency definition characteristics were used to do the statistics. Two-way mixed model has been used as specific raters are the only raters of interest (Dentist), which cannot be generalized to other population. K raters since there are about 40 dentists involved. Consistency definition was used since the raters were correlated in additive manner.

The overall results imply that there was mostly poor & moderate agreement between the raters. Though there is statistical significant p value, the cronbach's alpha value implies mostly poor to moderate agreement in both the methods (Nollas & Demirjians).

In spite of few good agreements in both the methods, yet a clear gold standard image interpretation must be needed.

III. RESULT

On doing intra-class reliability test, with two –way mixed model rates type and consistency definition characteristics the results showed poor agreement and good agreement in Nollas and Demirjians method for central incisor with P value of 0.08 and 0.00 respectively. Similarly for Lateral incisor the Cronbach's X value showed poor and moderate agreement in Nollas and Demijirians method with a P value of 0.02 and 0.00 respectively. Nollas and Demirjians method for Canine with a sample of 40 showed moderate and poor agreement with a P value of 0.00 and 0.28 respectively. For 1st molar the agreement was found to be good in both Nollas and Demirjians method with a P value of 0.00.Any way the agreement was poor and moderatein Nollas and Demirjians method with a P value of 0.21 and 0.00 respectively. Nollas and Demirjians method has good agreement for identification of 1st molar with a P value of 0.00.Anyway the agreement found to be moderate and good for 2nd molar with a P value of 0.00.Nollas method for identificiation of 3rd molar was found to have poor agreement with a P value of 0.09.

Only 1st premolar and 1st molar has good agreement with cronbach's X value of 0.9 in both Nollas and Demirjians method. Intera class showed mostly poor and moderate agreement for the rest of the teeth in both the methods.

IV. DISCUSSION

Age estimation has always been a challenging issue in both the living and the dead. While forensic age determination has varied tests and methods the estimation of age in living individuals especially minor children need noninvasive techniques.

The problems associated with asylum seekers and illegal migrants from the conflict zones of the world to developed countries accepting them on humanitarian grounds has increased the need for these techniques, as most of the minors sometime end up in migration camps without parents accompanying them[14],[15].

The developed countries themselves have a well-established public health, educational and legal systems which are sensitive to the age and development of the individual. Which means under estimation in an individual will result in undue benefits or overestimation of age can result in harsher punishments in legal system. Where as in the educational system they can be made to continue in a lower grade or can have problems in coping up with a higher grade class if the age estimation hadn't been accurate.

The demirjians and the Nolla's techniques have been the widely used techniques of age estimation till date. They also have undergone their fair share of reassessment to include the third molar in order to be more comprehensive and to extend their range of usefulness.

In a study from Brazil, the Nolla's method was found to be superior than the Demirjians technique for the local ethnic population [4]

In an indian study, there was an overestimation of age in the Demirijians technique compared to the Camerierie technique.[6]

When these techniques were used in other regions of the word like Peru [5], Brazil [4]india [6],[7],[11] iran [16] Italy [8] Germany [9] Hongkong [10] Thailand[12] the reaserchers found that there as some difference in age and maturation between the ethnic groups. All these studies came with new formulae for age estimation based on the Demirjians Method.

The methods that used the corrective factors found the demirjians technique suitable for the euthenics group with the appropriate corrective factor [7],[16],[10]

There has been evidence that the identification of the stages of development of teeth are highly subjective and is prone to inter and intraobserver variability. These legal agencies and regulatory bodies need assessment that are reproducible and that s necessitates reduction in inter-observer variability.

Inter observer variability is a universal problem and is not ethnicity based. Which means though we develop ethnic group based formulae to use, the basic step of identification of the stage of development, if erred can confound the error further in following calculations.

This study aimed at assessing the problems in identifying the correct stage of tooth development. Forty dentists were asked to calculate the age of six OPG with mixed dentition. Their choice of the stages of tooth development of individual tooth was compared against the validated score of a senior pediatric dental consultant whose scoring yielded the actual age of the individual with an error of 3 months.

The individual scoring pattern was assessed with Intraclass correlation coefficient (Cronbach's Alpha) and was scored as good agreement -0.8 to 1, moderate agreement -0.6 to 0.7 and poor agreement -<0.5

The demirjians technique was a better technique compared to the Nollas as it scored good in 4 teeth and moderate in 2 and poor in 1 compared to good in 2 moderate in 2 and poor in 3 scored by the nolla's technique.

For an assessment to be accurate and reproducible in age estimation the identification of the developmental stage of the teeth needs to be accurate and in good agreement with the observer. The study has proved that though there are good agreement in teeth like the 1st molar and 1st premolar in both the technique, there is scope for improvement in the identification.

V.CONCLUSION

The present study shows that there is an significant difference using cronbach's alpha value in both demirjians and Nolla's method. The human eye is trained to pick up patterns, but the mind can be influenced by other factors like time, stress need to do other work etc. resulting in errors in judgment.

This error in judgment can result in improper scoring and subsequent error in assessment of the age. This error can be between subsequent observers or by the same observer at a different time. Computerization or automation of the process using the image processing technology can be the solution to this issue of errors in identification of the correct stage of tooth development. This may be possible because machines do not have fatigue or are not influence by external factors. This opens the need for a better identification of the stages of tooth development.

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