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Research Article

Age Determination Using Lateral Cephalogram and Orthopantomograph: A Comparative Study

Daya K. Jangam[1*], Priyanka Kale[2], Sana Fatema[3]

[1]Professor and Head of Department of Oral Medicine and Radiology, M A Rangoonwala College of Dental Sciences and Research centre, Pune-411001, Affiliated to Maharashtra University of Health Sciences, Nashik, India

[2]Post Graduate student, Department of Oral Medicine and Radiology , M A Rangoonwala College of Dental Sciences and Research centre, Pune-411001, Affiliated to Maharashtra University of Health Sciences, Nashik, India

[3] Post Graduate student, Department of Oral Medicine and Radiology, M A Rangoonwala College of Dental Sciences and Research centre, Pune-411001, Affiliated to Maharashtra University of Health Sciences, Nashik, India

***Corresponding author**
Dr. (Mrs.) Daya K. Jangam
Email: dayajangam@yahoo.in

Abstract: The identification of human skeletal remains is considered to be initial step in forensic investigation. Investigations of jaws and teeth, the most well preserved parts of human body have been proven a basic and valuable method in human identification. In an individual life, bony alteration takes place in the jaw bones which are thought to be influenced by the dental status and age of the patient. Dental radiographs are certainly one of the most desirable pieces of ante mortem evidence because of their highly objective nature as compared with other records. The present study aims to measure, compare and evaluate various radiological landmarks as observed in lateral cephalogram and orthopantomogram (OPG) and to assess their usefulness in age estimation and also to verify whether the detected age predicting skeletal variable(Ceph Markers) and related registration system for third molar development on OPG resulted in any improvement in age estimation. Age estimation by OPG was done using Demirjians Method and by Lateral Cephalogram using Rai *et al*. (RA) method was used for which 60 digital OPG and 60 digital lateral cephalograms of patients aged between 10 to 25yrs of which 21 males and 39 females were examined. Data was subjected to regression analysis. Thus in conclusion it can be said that by comparing lateral cephalometric and OPG parameters we found that lateral cephalometric parameters are more reliable for age estimation as compared to OPG and the derived formulas were matching nearly accurately with the known age of the subject.
Keywords: Age determination, Ceph markers, Third molar.

INTRODUCTION

Age estimation is one of the important duties of medico legal officers in recent time as crimes of varied nature are increasing [1, 2]. It is necessary to identify age not only in cases of living but also in the dead too, for identification of individual. Also age estimation is necessary for young asylum seekers in determining the legal age of the subject and for forensic purpose where dead body of a person claimed to be that of missing person, cases of unnatural death of unidentified bodies due to suspected foul play [3-5]. Forensic age estimation can combine methods based on 3rd molar development and sociopsychological maturity, physical appearance, secondary sexual development, radiologically observed secondary dentin apposition, degree of ossification of hand wrist bones, medial part of collar bone, costal cartilage of 1st rib [6, 7].

Teeth have been recognized as a valuable tool for establishing personal identity, as teeth are naturally preserved long after all the tissues and even bones have disintegrated. However, age estimation becomes difficult after 14 years of age since all permanent teeth except 3rd molar have completed development. Hence, 3rd molar offers a unique advantage over other teeth because its development continues over a longer period and until a later age [8, 9].

Also, on cephalometric radiographs, the developmental changes of cervical vertebrae were utlised to evaluate age. Also the development of mandibular bone was registered and used as a age predictor [10].

In the current study we would like to evaluate and compare the use of 3rd molar development on an OPG and various Ceph markers on lateral cephalogram for age estimation.

MATERIALS AND METHODS

Patients who came to the department of Oral medicine and Radiology in M.A Rangoonwala college of dental sciences for the purpose of undergoing orthodontic treatment of which 21 were males and 39 females between the age group of 10-25years were selected for the study.60 digital Orthopantomograms and 60 digital Lateral cephalograms *(Orthoralix Gendex)* were taken on the same day and were utilised for the study.

The inclusion criteria was subjects Belonging to age group of 10-25 years, with good oral hygiene and who gave voluntary consent for the study procedure.

The exclusion criteria subjects with any congenital anomalies of teeth or jaw, malnutrition or other diseases that would affect the skeletal growth and general development of the individual, subjects with history of third molar extraction were excluded.

Age proof was taken from the subjects in the form of birth certificate or school/college register or I.D card/ Driving licence.

To assess the developmental stages of third molars from the mandible, Demirjian`s classification system was adopted (Fig. 1) [3].

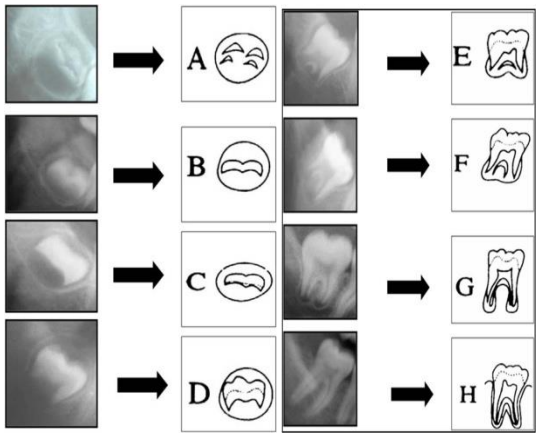

Fig. 1: Demirjian`s classification system

Stage A: Cusp tips are mineralized but have not yet coalesced,
Stage B : Mineralized cusps are united so the mature coronal morphology is well defined;
Stage C : The crown is about half formed ;the pulp chamber is evident and dentinal deposition is occurring;
Stage D : Crown formation is complete to the dentino-enamel junction. The pulp chamber has a trapezoidal form;
Stage E : Formation of the inter-radicular bifurcation has begun .Root length is less than the crown length;
Stage F : Root length is at least as great as crown length .Roots have funnel shaped endings;
Stage G : Root walls are parallel but apices remain open; Stage H : Apical ends of the roots are completely closed.

For the lateral cephalograms Rai et al method was adopted [1] Fig. 2

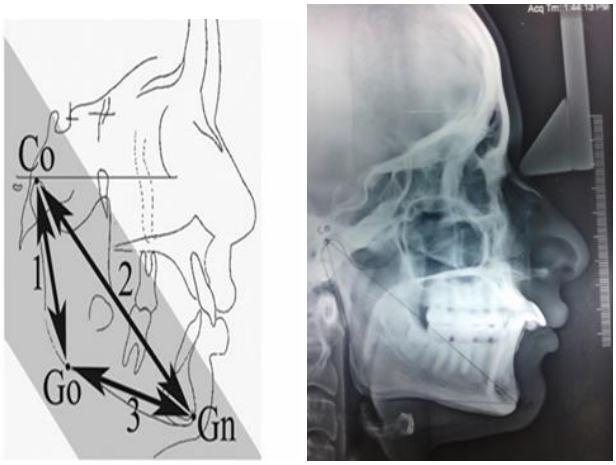

Fig. 2: Ceph Markers

Co(Condylion), Go- Gonion , Gn- Gnathion; The mandibular ramus height Co-Go; The mandibular length Co-Gn; The mandibular body length Go-Gn were marked on a tracing paper and measured in millimeters using a divider and a scale.

Regression analysis was performed and determination co-efficients (R^2) and root mean square errors (RE) were obtained. Gender and non-gender specific formulas for age determination were derived.

R^2 – indicates the proportion of the explained variability in the response variable age. The variable that leads to highest R^2 contains the maximum amount of information on age. RE- denotes the magnitude of error in age prediction.

RESULTS

There was no significant difference for right and left side of 3rd molar development (p- value = 0.0)

Table 1: The gender-specific prediction of age using regression analysis by OPG (3rd molar developmental stage)

Group	Regression Equation	R^2	SE of the estimate
Male	Age = 9.835 + 1.168 (DS)	74.7%	1.834
Female	Age = 9.040 + 1.438 (DS)	73.5%	1.875
Unknown gender	Age = 9.529 + 1.288 (DS)	73.2%	1.871

DS: Developmental stage expressed in numbers as follows: Stage O = 0, stage A = 1, stage B= 2, stage C= 3, stage D = 4, stage E = 5, stage F = 6, stage G = 7 and stage H = 8.

Table 2: The gender-specific prediction of age using regression analysis by Lateral cephalogram

Group	Cephalogram measurement (mm)	Regression Equation	R^2	SE of the estimate
Male	Ramus height (Co_Go)	Age = 2.814 x Co_Go	96.6%	2.958
	Body length (Go_Gn)	Age = 2.144 x Co_Go	96.2%	3.092
	Mandibular length (Co_Gn)	Age = 1.402 x Co_Gn	96.3%	3.056
Female	Ramus height (Co_Go)	Age = 2.996 x Co_Go	95.4%	3.462
	Body length (Go_Gn)	Age = 2.261 x Co_Go	95.0%	3.600
	Mandibular length (Co_Gn)	Age = 1.484 x Co_Gn	95.5%	3.429
Gender unknown	Ramus height (Co_Go)	Age = 2.912 x Co_Go	95.9%	3.265
	Body length (Go_Gn)	Age = 2.208 x Co_Go	95.6%	3.388
	Mandibular length (Co_Gn)	Age = 1.447 x Co_Gn	95.8%	3.276

Here, R^2 –determination co-efficient, SE – standard error of the estimate

DISCUSSION

In our study as per regression analysis the R2 reading ranged from 73-75% in OPG and 95-96% in lateral cephalogram analysis (higher the R^2 better the prediction of age).This indicates that the lateral cephalogram analysis can predict age better than OPG analysis and seem to be more reliable. This is contradictory to the findings of Thevissen *et al.* [1] who stated that the Rai *et al.* method contained very little information on age and their regression models explained maximally 3% of the variability in age. Also when comparing the various cephalometric age estimation methods it was predicted that Seedat (SE) technique [11], a technique for age estimation by cervical vertebrae allowed the best age estimation.

In cephalometric analysis ramus height, body length and mandibular length did not show much variation in **R^2** reading. Hence any one of these measurements can be reliably used for age prediction. However , according to Dibbets *et al.* [12] magnification inherent to the technique of radiographic projection should be taken into account when comparing linear dimensions on cephalometric data and that the Rai *et al.* technique is not allowing us to correct for magnifications of data from different sources.

In OPG the developmental stages the sub-stages are not considered whereas the readings in cephalogram are more accurate and can be measured successively as per the skeletal development. However, according to Kohler *et al.* [13] the development of third molars cannot be measured before the onset of calcification of third molars, neither when third molars are absent. This missing information may itself contain some information about age. Therefore he constructed four prediction models, including this information based on the present third molars: firstly upper and lower molars present; secondly, upper molar present; thirdly, lower molar present and fourthly, no third molars present. To apply the maximal available information, for each subject, the predictors were used, which agree with the missingness pattern for this subject. According to Leif Kullman [8] tooth development is an accurate measure of chronological age that seems to be independent of exogenic factors such as malnutrition or disease and also the single compelling reason to rely on third molar formation to estimate chronological age is that there are very few alternative methods during the interval roughly between the middle teens and early 20s. All of the hand-wrist bones have achieved their adult morphologies and their epiphyses have fused and the onset of secondary sex characteristics has occurred.

Also in our study there was no significant difference for right and left side of 3rd molar development. This finding is coincident with Jashwant *et al.* [3] who found that there was no significant difference in the third

molar development between left and right side in all eight stages of development.

Using the available data regression analysis was performed and formulas were derived for males, females and in cases where gender was unknown. The regression formulas helped determine age nearly accurately and matched with the known age of the subject.

However, by increasing the sample size the standard error variable can be reduced.

CONCLUSION

This study attempted to use the parameters of lateral cephalogram for age estimation. This is a preliminary study and very few studies for age estimation have been conducted previously using lateral cephlogram. Considering all the previous varying results from different studies, this study attempted to evaluate the usefulness of the OPG and lateral cephalogram for estimation of age and compare the predictability of either and it was found that that lateral cephalometric parameters are more reliable for age determination as compared to OPG and the derived formulas were matching nearly accurately with the known age of the subject. But further studies need to be conducted with more sample size so as to reduce the standard error and get more reliable results.

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