RELIABLE TOOTH INDICATOR IN KVAAL'S METHOD OF AGE ESTIMATION USING PANORAMIC RADIOGRAPHS - A CROSS-SECTIONAL STUDY.

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ABSTRACT:-

OBJECTIVE: - The objective of the study is to find the reliable tooth indicator in kvaal's method of age estimation by comparing between chronological age and dental age on digital panoramic radiographs. **MATERIALS AND METHOD:-** The present study was based on 100 panoramic radiographs, and various parameters were measured which is pulp length, tooth length, root length and, pulp and root widths at three different points. The ratios calculated according to Kvaal's technique were: the tooth/ root length (T), pulp: root length (P), pulp: tooth length(R) and pulp: root width at three different levels a, b and c, mean values of all ratios (M), mean value of width ratios from levels b and c (W); mean value of length ratios P and R (L). 'M' was taken as the first predictor and the difference 'W-L' as the second predictor and age of the patient is estimated based on kvaal's age estimation formula and then statistically analyzed. **RESULT**: - In the present study maxillary lateral followed maxillary second premolar are reliable indicators. It was observed that the coefficient of determination R was highest (0.304) for the upper second premolar considered together. No significant difference between the mean of the chronological age and the estimated age was observed in all teeth taken individually, three maxillary teeth taken together, three mandibular teeth taken together, and all the six teeth taken together. Lowest standard error of estimate (SEE) was seen with the upper lateral incisor followed by upper second premolar.

KEY WORDS:- Age estimation, digital panoramic radiograph, Kvaal's method, Panoramic radiograph

INTRODUCTION:-

Age determination has become increasingly important in forensic science[3]. In this multicultural society, for legal queries in delineating juvenile and young adults, in the case of employment, labor acts

or any criminal offences, dental age estimation has gained acceptance because it is less variable than skeletal and sexual maturity indicators[2, 7, 11].

Saunders, a dentist, was the first to publish information regarding dental implications in age assessment by presenting a pamphlet entitled ‘‘Teeth A Test of Age’’ to the English parliament in 1837. While quoting the results from his study on 1000 children, he pointed out the value of dentition in age estimation.[1]

Radiology plays an important role in age estimation. Since 1982, dental radiography, a non-destructive and simple technique used daily in dental practice, has been employed in methods of age estimation[9].

Many age estimation methods were proposed from the past, but there is lack of standardization and consensus concerning which method can be used [17, 18]. Age estimation methods for children are more reliable as there will be developing teeth[13, 15]. But it becomes little difficult when dealing with adult age estimation.

Kvaal's method in 1995 established an age estimation method that allows estimation based on morphological measurements of two-dimensional radiographic features of individual teeth[10]. Kvaal’s is one of the proposed methods for adult dental age estimation, which is volumetric assessment method that measures age based on reduction in the volume of the pulp. It is a non-invasive method[11]. He used six mandibular and six maxillary teeth with their pulp – tooth ratios.

MATERIALS AND METHOD:-

The study sample consisted of a total of 75 patients, consisting of 42 males and 33 females in the age group of 25-60 years with a mean age of 40.49 years, selected from those visiting the department of oral medicine and radiology and requiring digital panoramic radiographs for various reasons of diagnosis and treatment planning.

Inclusion criteria: -

Digital panoramic radiographs for patients ages between 25 to 60 years, Presence of kvaal’s criteria tooth which are completely erupted without any morphological abnormalities either on right or

left side i.e. maxillary central incisor, maxillary lateral incisor, maxillary second premolar, mandibular lateral incisor, mandibular canine, and mandibular first premolar

Exclusion criteria: -

Faulty radiographs and teeth with developmental anomalies extensive caries, severe malocclusions like rotations, crowding, etc., which may cause difficulty in placing reference points to measure, pregnant women to avoid unnecessary radiation exposure, patients with syndrome-associated diseases that affect tooth development.

Panoramic radiograph was taken with digital OPG machine with specifications MODEL: - VATECH, PaX-400C, Power source:-110V/ 230V-50/60Hz, 2.0KVA (MAX) and Weight: - 200kg.

Measurements were performed on the standardized digital panoramic radiograph based on Kvaal's method for the six study teeth i.e., central incisor, lateral incisor, second premolar of maxillary arch and lateral incisor, canine and first premolar of mandibular arch which may be either the left or right side (FIGURE 1). Mouse driven cursor was used to locate the reference points and following measurements were taken to measure tooth length (T), pulp length (P),root length(R) and pulp& root width at three different levels A(at cement enamel junction), C(at mid-root level) and B(mid point in between A and C) (FIGURE 2, 3 and 4). Pulp width denoted as a, b, c and root width denoted as A, B, C at points A, B and C respectively for convenience and then ratios were done.

All the measurements were performed by a single observer. Ratios between the length and width measurements of the same tooth were calculated in order to avoid measurement errors due to difference in the magnification of the image on the radiograph. The ratios calculated according to Kvaal's technique were: Tooth length/root length (T), pulp length/root length (P), pulp length/tooth length (R), pulp width/root width at level “a” (A), pulp width/root width at level “b” (B), pulp width/root width at level “c” (C). The data was analyzed with Pearson co-relation with Statistical Package for Social Sciences (SPSS) for Windows 20.0 (SPSS, Inc.chicago, Illinois). Confidence intervals were set at 95% and values of $p < 0.05$ were interpreted as statistically significant. The statistical formulas used were mean, standard deviation (SD), correlation, regression, and coefficient of determination.

RESULTS: - The present study included 75 subjects (42 males and 33 females) of either sex between age group of 25 and 60 years for assessment of age. The mean age group being 40.49 years (FIGURE 5). Apart from the ratios mentioned above, the following were also calculated: Mean of all six ratios (M), mean of width ratios B and C (W), mean of length ratios P and R (L), and difference between width ratio "W" and length ratio "L"(W ~ L). Correlation was calculated between chronological age and ratios for all six teeth, maxillary teeth, and mandibular teeth taken together (TABLE 1). After correlation, regression analysis was done to formulate regression equations for assessment of age. Regression equations for age were derived for all six kvaal's criteria teeth, three maxillary teeth, three mandibular teeth, and all six teeth considered together with age as the dependent variable and T,P,A,B,C,M and W-L as predictors.. Regression equations were derived for each tooth (TABLE 2).

It was observed that the coefficient of determination R was highest (0.304) for the upper second premolar considered together. The age of the subjects was estimated by substituting the values of T, P, A, B, M and "W ~ L" in the derived regression equations, and this estimated age was compared with the chronological age using Student's *t*-test (TABLE 3). No significant difference between the mean of the chronological age and the estimated age was observed in all teeth taken individually, three maxillary teeth taken together, three mandibular teeth taken together, and all the six teeth taken together. Lowest standard error of estimate (SEE) was seen with the upper lateral incisor followed by upper second premolar (TABLE 4).

DISCUSSION: - Dental age estimation has gained acceptance because it is less variable when compared to other skeletal and sexual maturity indicators[5, 6, 12] . Gustafson developed the first systematic dental method for the estimation of age in adults[2,4]. Kvaal has developed age estimation method based on pulp tooth ratio which is based on radiographs and has gained advantage as a non-invasive technique. The study was based on the principle that, with the advancing age the size of dental pulp cavity is reduced as a result of secondary dentine deposition occurs, so that measurement of this reduction can be used as an age estimation criteria[14]. Original kvaal's method was done using intra-oral periapical radiographs, but it increases radiation dose to the patient and also time consuming. Later studies were conducted using panoramic radiographs[16]. Panoramic radiographs avoid the need for taking multiple intraoral radiographs,

can be applied to living persons, and do not require extraction of teeth also reducing patient exposure and regression formulas were derived for the study conducted population[8]. It allows the age estimation of individuals older than 21 years of age, at the end of skeletal growth and development. Measurements were made according to kvaal's method. To compensate for differences in magnification and angulations on radiographs, the ratios of all measured parameters were taken (T/R, P/R, P/T, etc.)[4]. The accuracy of this method depends on the precision of the measurements and the quality of the panoramic radiographs. Factors that may interfere would be caries, dental fillings, any developmental anomalies, etc., Also studies conducted to determine the most significant teeth and significant indicator of all the six teeth. According to Piyush G. Limdiwala,et al.,(2013), Three maxillary teeth are significant. According to Chandramala R, Sharma R, (2012) Upper Central incisor, Lower first premolar Upper teeth→"M" Lower teeth→ "W-L" are significant. In the present study, Upper lateral incisor, upper 1st premolar W-L, C, W, W-L. In my study, 22 and 25 teeth are more reliable indicators in age estimation using KVAAL'S method.

CONCLUSION:-In the present study width ratios were more significant than length ratios and maxillary teeth were more reliable indicators. Kvaal's technique can be applied using upper lateral and second premolar in the present study and further studies with more sample size is needed for more significant values.

REFERENCES:-

1. Panchbhai AS. Dental radiographic indicators, a key to age estimation. Dentomaxillofacial Radiology. 2011 May;40(4):199-212.
2. Mittal S, Nagendrareddy SG, Sharma ML, Agnihotri P, Chaudhary S, Dhillon M. Age estimation based on Kvaal's technique using digital panoramic radiographs. Journal of forensic dental sciences. 2016 May;8(2):115.
3. Piyush G. Limdiwala and J. S. Shah, Age estimation by using dental radiographs, J Forensic Dent Sci. 2013 Jul-Dec; 5(2): 118–122.
4. Kvaal SI, Kolltveit KM, Thomsen IO, Solheim T. Age estimation of adults from dental radiographs. Forensic Sci Int. 1995;74:175–85.
5. Chandramala R, Sharma R, Khan M, Srivastava A (2012) Application of Kvaal's Technique of Age Estimation on Digital Panoramic Radiographs. Dentistry 2:142.
6. Willems G, Moulin-Romsee C, Solheim T. Non-destructive dental-age calculation methods in adults: intra- and inter-observer effects. Forensic Sci Int. 2002;126:221–6.]
7. González-Colmenares G, Botella-López MC, Moreno-Rueda G, Fernández-Cardenete JR. Age estimation by a dental method: A comparison of lamendin's and prince and ubelaker's technique. J Forensic Dent Sci. 2007;52:1156–60.
8. Paewinsky E, Pfeiffer H, Brinkmann B. Quantification of secondary dentine formation from orthopantamograms - A contribution to forensic age estimation methods in adults. Int J Legal Med. 2005;119:27–30.
9. Sharma R, Srivastava A. Radiographic evaluation of dental age of adults using Kvaal's method. J Forensic Dent Sci. 2010;2:22–6.
10. Meinl A, Tangl S, Pernicka E, Fenes C, Watzek G. On the applicability of secondary dentin formation to radiological age estimation in young adults. J Forensic Sci. 2007;52:438–41.
11. Patil SK, Mohankumar KP, Donoghue M. Estimation of age by Kvaal's technique in sample Indian population to establish the need for local Indian-based formulae. J Forensic Dent Sci. 2014;6:166–70.

12. Smith BG, Robb ND. The prevalence of tooth wear in 1007 dental patients. J Oral Rehabil. 1996;23:232–9.

13. Santoro V, De Donno A, Marrone M, Campobasso CP, Introna F. Forensic age estimation of living individuals: a retrospective analysis. Forensic science international. 2009 Dec 15;193(1-3):129-e1.

14. Godge P, Sharma S, Vibhakar P, Kulkarni S, Shroff J. Age estimation using orthopantomographs-a forensic study. IJOCR. 2014;2(6):26-30.

15. Liversidge HM, Herdeg B, Rösing FW. Dental age estimation of non-adults. A review of methods and principles. InDental anthropology 1998 (pp. 419-442). Springer, Vienna.

16. Anthropology and Medicine: Complementary Sciences from Recovery to Cause of Death. Totowa, NJ: Human Press Inc; 2006. pp.238–9.

17. Cunha E, Baccino E, Martrille L, Ramsthaler F, Prieto J, Schuliar Y, et al. The problem of aging human remains and living individuals: A review. Forensic Sci Int. 2009;193:1–13.

18. Babshet M, Acharya AB, Naikmasur VG. Age estimation in Indians from pulp/tooth area ratio of mandibular canines. Forensic Sci Int. 2010;179:125.e1–4.

FIGURE 1:Six reference teeth as taken in kvaal's method which can taken on be right or left side

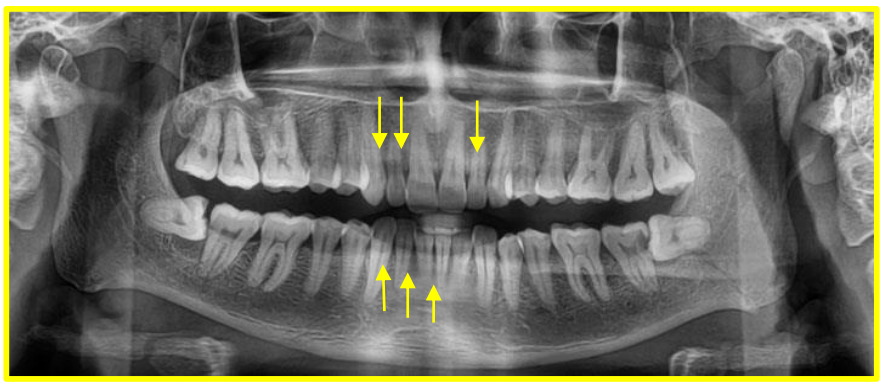

FIGURE 2:-Measurements done for tooth length (T), pulp length (P),root length(R) and pulp& root width at three different levels A(at cement enamel junction), C(at mid-root level) and B(mid point in between A and C)

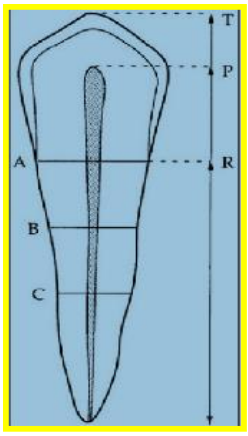

Figure 3:- Measuring the pulp length

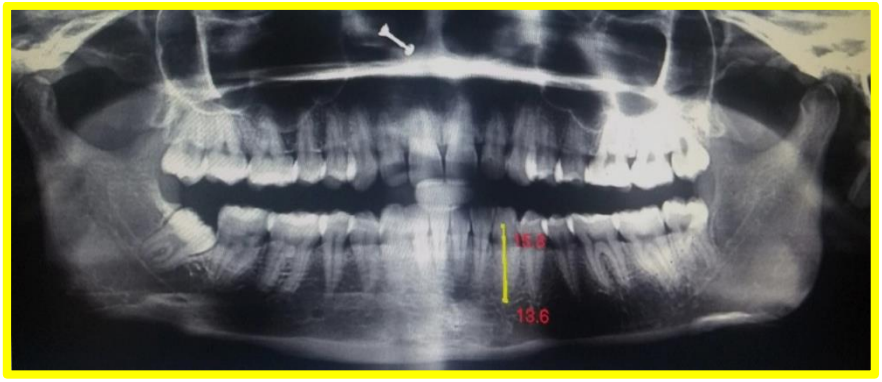

FIGURE 4:- Measuring the root width at points A(at Cementoenamel junction), C (Midroot level), B(A point between A and C).

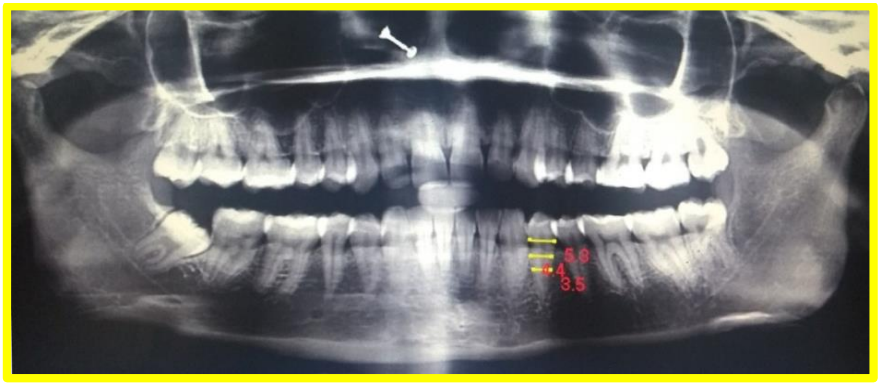

FIGURE 5:- Age disribution with mean age distribution

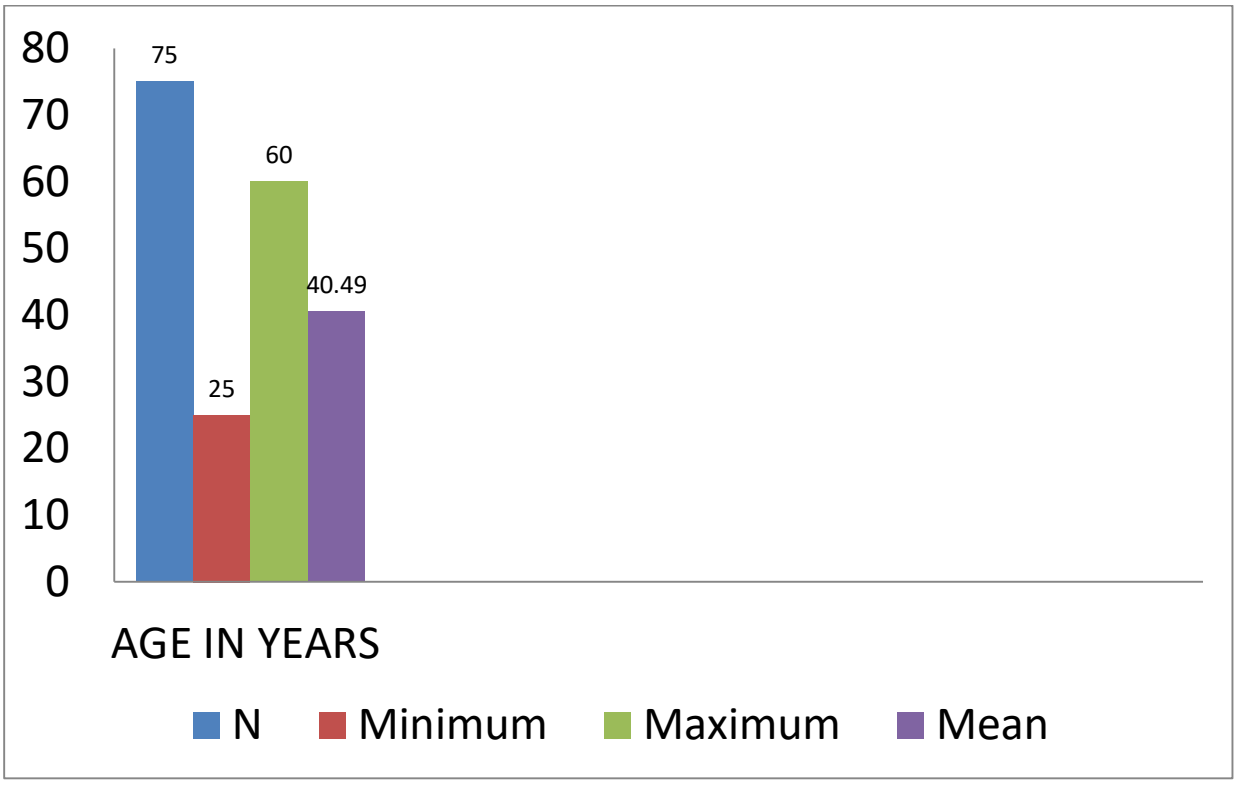

TABLE 1 : CORRELATION BETWEEN AGE AND THE RATIOS OF MEASUREMENT

	Upper Central Incisor	Upper Lateral Incisor	Upper second premolar	Lower lateral incisor	Lower Canine	Lower first premolar
P	-0.081	-0.244	-0.306	-0.237	-0.398	-0.177
T	-0.346	-0.290	-0.472	-0.110	-0.273	-0.078
R	-0.314	-0.130	-0.077	0.108	0.105	0.219
A	-0.181	-0.302	0.037	-0.289	-0.107	-0.174
B	-0.176	-0.207	0.198	-0.095	0.135	-0.083
C	-0.032	-0.021	0.216	-0.133	0.116	-0.207
M	-0.362	-0.314	-0.025	-0.159	-0.048	-0.143
W	-0.120	-0.125	0.235	-0.123	0.145	-0.173
L	-0.360	-0.260	-0.373	-0.014	-0.152	0.037
W-L	-0.360	0.143	0.407	-0.059	0.216	-0.187

TABLE 2 : REGRESSION FORMULAE FOR AGE IN YEARS BASED ON DENTAL RADIOGRAPHS FROM SIX TEETH

Teeth number	EQUATION FOR ESTIMATED AGE	R^2	**Significant predictors**
21	203.893+(-82.561×21T)+(-287.350×21R)+(-54.466×21A) +(53.336×21A)+(34.699×21M)+(-120.467×21W-L)	0.184	W-L, T, M, A,C, R
22	558.371+ (-338.765×22t)+(-1130.644×22R)+ (-1130.644×22R)+(-278.181×22A)+(-46.308×22B)+ (242.338×22M) + (-412.039×22w-L)	0.239	W-L, M, T, A, B, R
25	43.776+(26.623×25T)+(170.436×25R)+(31.469×25A)+ (11.256×25C)+(-41.246×25M) +(110.293×25W-L)	0.304	W-L, T, M, A, C, R
32	125.125+(-64.840×32T)+(-135.747×32R)+(-85.594×32A) +(36.354×32B)+(30.070×32M)+ (-65.562×32W-L)	0.144	W-L, T, M, A, B, R
33	171.778+(-100.673×33T)+(-160.589×33R)+(-89.654×33A) +(19.509×33B)+(42.814×33M)+ (-55.857×33W-L)	0.208	W-L, M, T, A, B, R
34	NOT SIGNIFICANT	0.108	W-L, T, L, A, B, R

TABLE 3: COMPARISON OF STANDARD DEVIATION FOR ACTUAL AGE AND ESTIMATED AGE

TOOTH	MEAN OF CHRONOLOGICAL AGE	MEAN OF ESTIMATED AGE
11/21	40.49 ±9.933	40.49 ± 9.427
12/22	40.49 ±9.933	40.49 ± 9.508
15/25	40.49 ±9.933	40.49 ± 9.996
32/42	40.49 ±9.933	40.49 ± 9.795
33/43	40.49 ±9.933	40.49 ± 9.965
34/44	40.49 ±9.933	40.49 ± 9.846
All six teeth	40.49 ±9.933	40.49 ± 9.549
Maxillary teeth	40.49 ±9.933	40.49 ± 9.547
Mandibular teeth	40.49 ±9.933	40.49 ± 9.792

TABLE 4: STANDARD ERROR OF ESTIMATE FOR INDIVIDUAL TOOTH	
TEETH	STD. ERROR OF THE ESTIMATE
11/21	9.363
12/22	9.040
15/25	8.643
32/42	9.586
33/43	9.223
34/44	9.786