Relationship of Dental and skeletal Radiograph: Maturity Indicator

B Rai

Citation

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Abstract

The purpose of this study was to investigate the relationship between the stage of calcification of various teeth and skeletal maturity stages among Indians individuals. The study subjects consisted of 34 male subjects and 32 female subjects ranging in age from 9 to 21 years. A total of 66 panaromic radiographs and cephalograms were obtained and analyzed. Skeletal age and skeletal maturity stages were determined form cephalogram by using the method of Hasal and Farmen. The tooth development of mandibular canines, first and second premolars and second molars were assessed according to the Demirjian system. The second molar was the tooth showing the highest correlation. This suggested that tooth calcification stages from panaromic radiographs might be clinical useful as a maturity indicator after pubertal growth period.

INTRODUCTION

Hand wrist radiographs have been used for calculation as skeletal age for many years. The ossification and development of the carpal bones of the wrist, the metacarpals of the hands, and the phalanges of the fingers form a chronology of skeletal development. A satisfactory hand wrist radiograph can be made utilizing a standard cephalometric cassette and a dental x-ray or the cephalometric x-ray source. In use, the overall pattern observed in the hand-wrist film is compared with age standards in a reference atlas [1] to obtain a skeletal age for the patient. In addition, the status of certain specific landmarks such as the ulnar sesamoid or hamate bones can be used to obtain as estimate of the timing of the adolescent growth spurt. [2] Various areas of the skeleton have been used : the foot, the ankle, the hip, the elbow, the hand wrist, and the cervical vertebrea. [3]

MATERIALS AND METHODS

MATERIALS SELECTION

The study sample consisted of 66 patients (M:F :: 34:32) selected from Department of Orthodontics, Government Dental College and Hospital associated with Pt. B.D. Sharma Postgraduate Institute of Medical Science, Rohtak (Haryana). Hand wrist panoramic radiographs and cephalogram of 66 patients were taken.

The selection criteria included:

- The subjects had normal dental conditions.
- The subjects had undergone neither previous orthodontic treatment nor extraction of any permanent teeth.

Assessment of parameters:

A.Tooth calcification from panoramic radiographs was rated according to the method described by Demirjian et al. [6] In which 8 stages of calcification.

Left mandibular teeth in panoramic radiographs were examined. In case of any missing left mandibular teeth, the right teeth corresponding to the missing teeth were substituted. Mandibular incisor and first molars were not rated because apical closure had already take place.

To evaluate the stage of skeletal maturation of each cephalogram according to the method described by Hassel and Farman [3] .

The following six stages in vertebrae developments:

Stage 1 : This stage called initiation corresponds to beginning of adolescent growth expected with 80 to 100 % of adolescent growth expected. Inferior borders of C_2, C_3 and C_4 were flat at this stage. The vertebrae were wedge shaped, and the superior vertebral borders were tapered from posterior to anterior.

State 2 : The second stage is called acceleration. Growth acceleration begins at this stage, with 65% to 85% of adolescent growth expected. Concavities were developing in the inferior borders of C_2 and C_3. The inferior border of C_4 was flat. The bodies of C_3 and C_4 were nearly rectangular in shape.

State 3 : The third stage called transition, corresponded to acceleration of growth towards peak height velocity with 25% to 65% of adolescent growth expected. Distinct concavities were seen in the inferior borders of C_2 and C_3. A concavity was beginning to develop in the inferior border of C_4. The bodies of C_3 and C_4 were rectangular in shape.

Stage 4 : This stage called deceleration, corresponds to deceleration of adolescent growth spurt with 10 to 25% of adolescent growth expected. Distinct concavities were seen in the inferior borders of C_2, C_3 and C_4. The vertebral bodies of C_3 and C_4 were becoming more square in shape.

Stage 5 : The fifth stage is called maturation. Final maturation of the vertebrae took place during this stage, with 5 to 10% of adolescent growth expected. More accentuated concavities were seen in the inferior borders of C_2, C_3 and C_4. The bodies of C_3 and C_4 were nearly square to square in shape.

Stage 6 : This stage is called completion corresponds to completion of growth. Little or no adolescent growth could be expected. Deep concavities were seen in inferior border of C_2, C_3 and C_4. The bodies of C_3 and C_4 were square or were greater in vertical dimension than in horizontal dimension.

All of the assessments were made simultaneously on an illuminated viewing box in dark room. The interpretations of hand wrist, panorgamic and cephalometric radiographs were discussed until agreement was reached. Exact chronological ages were verified by reference to the patient's birth date. The entire data collected were subjected to statistical an analysis by using SPSS (SPSS Inc., Chicago, Illinosis).

RESULTS

Figure 1

Table 1 : Mean and standard deviation of chronological and skeletal age by Fishman method (Hand wrist radiographs) and by Hasssel and Farman method (Cephalogram).

Skeletal maturity stages		Chronological age (in years) Mean + S.D.		According to Hassel and Farman method (in years) Mean + S.D.	
Fishman	Hassel	Male	Female	Male	Female
MP_3	Stage 1	11.6±1.2	10.1±1.3	11.21±1.22	9.94±0.96
S	Stage 2	11.8±1.4	10.8±1.2	11.85±1.05	10.78±0.89
MP_{3Cap}	Stage 3	17.7±1.5	11.7±1.5	12.08±1.09	11.33±1.13
MP_{3Cap}	Stage 4	15.2±1.4	12.0±1.4	14.50±1.07	13.91±0.99
DP_{3u}	Stage 5	14.7±1.3	13.8±1.2	15.40±1.02	14.87±0.96
MP_{3u}	Stage 6	16.8±1.2	14.6±1.2	17.37±1.26	16.27±1.25

Figure 2

Table 2 : Percentage distribution of calcification stages of canine at MP, S, MP MP, DP, and MP stage

Stages	MP_3		S		MP_{3Cap}		MP_{3Cap}		DP_{3u}		MP_{3u}	
	F	M	F	M	F	M	F	M	F	M	F	M
D	2.2	-	-	-	-	-	-	-	-	-	-	-
E	14.6	5.2	5.1	4.3	2.3	1.3	-	-	-	-	-	-
F	65.2	51.1	47.7	32.4	25.6	4.2	5.6	1.2	4.8	0	1.8	0
G	12.5	20.9	30.4	27.3	24.4	14.9	12.8	10.5	18.8	11.8	4.8	6.8
H	7.5	17.9	17.1	28.0	47.3	75.8	70.0	86.5	76.4	88.2	94.5	93.5
I	1.0	4..7	1.0	8.0	1.4	2.8	10.6	1.8	0	0	2.5	0

The canine stage H in male and female at MP_{3u} showed highest percent distribution.

Figure 3

Table 3 : Percentage distribution of calcification stages of second molar at MP, S, MP MP, DP, and MP stage

Stages	MP_3		S		MP_{3Cap}		MP_{3Cap}		DP_{3u}		MP_{3u}	
	F	M	F	M	F	M	F	M	F	M	F	M
D	25.3	21.2	10.3	8.3	3.4	2.1	1.4	0	0	0	0	0
E	53.5	49.5	52.5	49.2	27.1	26.9	29.1	30.1	7.6	6.3	2.8	0
F	11.7	11.8	23.8	21.3	38.5	37.9	48.5	58.2	21.5	39.5	52.5	51.7
G	9.5	10.8	15.4	14.9	21.5	20.9	12.5	11.3	55.8	59.3	44.7	48.3
H	0	0	0	5.9	10.2	9.8	9.2	0	13.8	0	0	0
I	0	0	0	-	0	0	0	0	2.3	0	0	0

Second molar stage G in males and females at DP_{3u} showed

highest percent distribution of calcification.

Figure 4

Table 4 : Percentage distribution of calcification stages of first pre-molar at MP, S, MP MP, DP, and MP stage

Stages	MP_3		S		MP_{3Cap}		MP_{3Cap}		DP_{3u}		MP_{3u}	
	F	M	F	M	F	M	F	M	F	M	F	M
D	4.1	0	2.7	0	1.3	0	0	0	0	0	0	0
E	44.4	17.3	26.5	6.5	30.5	9.1	12.6	9.3	1.2	0	0	0
F	33.5	43.7	38.3	17.5	42.4	9.1	27.1	9.3	3.9	0	1.3	0
G	12.4	21.6	11.4	49.7	15.4	81.8	29.4	81.5	5.3	2.4	8.1	0
H	5.1	17.4	9.1	26.3	4.1	0	32.7	0	84.6	97.6	85.6	100
I	0	0	0	0	0	0	0	0	0	0	0	0

The first molar stage H in males and females at MP_{3u} showed highest percentage distribution of calcification.

Figure 5

Table 5 : Percentage distribution of calcification stages of second pre-molars at MP, S, MP MP, DP, and MP stage

Stages	MP_3		S		MP_{3Cap}		MP_{3Cap}		DP_{3u}		MP_{3u}	
	F	M	F	M	F	M	F	M	F	M	F	M
D	0	0	3.7	0	0	0	0	0	0	0	0	0
E	53.3	26.5	23.9	5.3	17.5	0	18.1	0	0	0	1.2	0
F	31.2	47.6	55.2	38.0	35.1	12.0	34.3	11.2	21.5	0	2.1	21.3
G	15.5	16.7	11.5	44.7	27.8	44.3	29.1	45.1	44.2	11.3	15.5	75.4
H	0	9.1	5.7	11.0	19.6	43.7	17.4	43.7	33.3	88.7	81.3	3.3
I	0	0	0	0	0	0	0	0	0	0	0	0

Second premolar stage H in males at DP_{3u} and females at MP_{3u} showed highest percent distribution of calcification.

Figure 6

Table 6: Correlation coefficient between skeletal and dental development stages in male and female subjects.

Tooth	Correlation coefficient (r value)	
	Males	Females
Canine	0.58	0.52
First premolar	0.69	0.58
Second premolar	0.42	0.43
Second molar	0.73	0.69

$p<0.01$.

Highest correlation coefficient showed by second premolar in male and female.

DISCUSSION

From the current study, maturation patterns of tooth development have shown that males tend to be more advanced as compared with females in relation to skeletal maturity stages as previous study. [7] The correlation coefficient between skeletal maturity and calcification stages of the teeth, were quite high, ranging from 0.42 to 0.73 and were statistically significantly significant ($p<0.01$). Chartkow et al. [8] and Coutinho et al. [9] have suggested a high relationship between calcification of mandibular canine and skeletal maturity indicators while in this study mandibular second molar in male as well as female. By the time the skeletal age assessment was performed, hand wrist radiographs and cephalograms from male subjects clearly differed from the standard plates more frequently than those of the female subjects, particularly in carpal bone area, which always showed less maturity compared with the other bones as by Acheson et al. [10] and Carpenter and Lester. [11]

The skeletal correlation with orthopedic appliances such as frankel appliance, Herbst appliance and cervical pull head could be initiated during the accelerating growth period and continued through the peak velocity period, depending on the severity of skeletal mal-relationship.

From the present study, the relationship between the tooth calcification stages and the skeletal maturity indicators probably allows the clinician to more easily identify the stages the pubertal growth period from the panoramic radiographs. The second molar was the tooth showing the highest correlation.

CONCLUSION

Second molar was the tooth showing the highest correlation. If a strong association exists between skeletal maturity and dental calcification stages, the stages of dental calcification might be used as a first level diagnostic tool to estimate the timing of the pubertal growth spurt. The ease of recognizing dental developmental stage, together with availability of intra-oral or panoramic radiographs in most orthodontic or pediatric dental practice, are practical reasons for attempting to assess physiologic maturity without resorting to other radiographs. Hence, the study further recommended a large sample size and should address development of second molars.

CORRESPONDENCE TO

Dr. Balwant Rai S/o Sh. Ramsawroop Village – Bhangu Distt. Sirsa Post Office – Sahuwala I. E-mail :

drbalwantraissct@rediffmail.com Mobile No. :
091-9812185855

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Author Information

Balwant Rai, B.D.S.
Editor in Chief internet Journal Of Dental Science