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Research Article

Correlation between Dental Maturity and Cervical Vertebral Maturity amongst 7 – 15 Year Old Kashmiri Children

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Abstract: The study was conducted to evaluate the relationship between stages of calcification of teeth and the cervical vertebral maturity stages in Kashmiri children 7-15 years of age. Orthopantomograph and lateral skull cephalograms of 77 patients (40 females and 37 males from 7-15 years of age) were examined. Dental maturity was evaluated by calcification stages of the mandibular cuspids, first, second bicuspids and second molars. Skeletal maturity was assessed by the cervical vertebral maturation (CVM) stages. Spearman rank-order correlation coefficient was used for statistical analysis. The mean chronologic age of males was significantly higher than females in each CVM stage. The Spearman rank-order correlation coefficients between dental maturity and cervical vertebral maturity ranged from 0.403 to 0.531 for girls and from 0.461 to 0.512 for boys. In girls, the mandibular second molar had the highest and the canine the lowest correlation. In boys, the mandibular second premolar had the highest and canine the lowest correlation. Tooth calcification stage was significantly correlated with cervical vertebral maturation stage. The development of the mandibular second molar in females and that of the mandibular second premolar in males had the strongest correlations with cervical vertebral maturity.

Keywords: teeth, Kashmiri children, dental maturity, cervical vertebral maturity, second molar.

INTRODUCTION

Skeletal maturity and dental development assessment is a common clinical practice in many health professions, especially for growth modification in orthodontics, dentofacial orthopedics and for age estimation. Because of the considerable variations in development among children, chronological age may have little or no role in the determination of the maturation stage of a child [1–3] and has led to the concept of biologic or physiologic age. Physiologic age is the rate of progress toward maturity and is estimated by somatic, sexual, skeletal or dental maturity.[3–5]

The most common and widely used method for skeletal-age evaluation is the hand-wrist bone analysis. Currently, cervical vertebrae analysis is widely employed by orthodontists to evaluate skeletal maturity because of the simplicity, objectivity and repeatability of using the routine lateral cephalogram. Lamparski[6] in 1972 gave the standards of cervical vertebral maturation for boys and girls. Hassel and Farman [7] detailed these cervical vertebra maturation indexes and stated that the cervical vertebral analysis can be used in the assessment of skeletal maturity.

Dental maturity can be determined by the stage of tooth eruption but tooth formation has been proposed as a better method for determining dental maturation [8,9,10]. Dental maturity has been widely investigated as a potential predictor of the skeletal maturity level.[11,12,13] Generally, the dental development can be assessed by either the phase of tooth eruption or the stage of tooth calcification, with the latter being more reliable.[14,15] The correlation between calcification

stage of individual teeth and skeletal maturity has been reported however little is known, however, about the association between tooth calcification stage and cervical vertebral maturation (CVM) stage. The aim of the present study was to investigate the association between dental and skeletal maturity by evaluating the correlation between tooth calcification stage and CVM stage.

MATERIALS AND METHODS

This study was conducted amongst 77 Kashmiri children 7-15 years of age in which panaromic radiographs and lateral skull cephalograms were evaluated. Amongst 77 children, 40 girls and 37 boys aged 7-15 years were selected. The subjects were randomly chosen from patients attending the Department of Oral Medicine & Radiology, Govt Dental College, Srinagar from June 2014 to July 2015.

The children belonging to Kashmir division, availability of digital panaromic radiographs and lateral cephalograms were included in the study. Exclusion criteria included image deformity affecting the estimation of tooth development, hypodontia, gross pathology and missing mandibular permanent teeth except the third molars, any systemic disease that could affect general development and history of orthodontic treatment.

The stages of cervical vertebra development and tooth formation of each subject were assessed.

DENTAL MATURITY ASSESSMENT

Dental maturity was assessed according to the calcification stages of individual teeth [10]. The developmental stages of the left mandibular permanent canines, first and second premolars, and second molars were rated on an 8-stage scale from A to H:

A. Calcification of single occlusal points without fusion of different calcifications.

B. Fusion of mineralization points; the contour of the occlusal surface is recognizable.

C. Enamel formation is complete at the occlusal surface, and dentin formation has commenced. The pulp chamber is curved, and no pulp horn is visible.

D. Crown formation is complete to the level of the cementoenamel junction. Root formation has commenced. The pulp horns are beginning to differentiate, but the walls of the pulp chamber remain curved.

E. The root length remains shorter than the crown height. The walls of the pulp chamber are straight, and the pulp horns are more differentiated than in the stage D. In molars, the radicular bifurcation has started to calcify.

F. The walls of the pulp chamber form an isosceles triangle, and the root length is equal to or greater than the crown height. In molars, the bifurcation has developed sufficiently to give the roots a distinct form.

G. The walls of the root canal are parallel, but the apical end is partially open. In molars, only the distal root is rated.

H. The root apex is completely closed (distal root in molars). The periodontal membrane surrounding the root and apex is uniform in width throughout.

SKELETAL MATURITY ASSESSMENT

Skeletal maturity was evaluated by the CVM method [11,12]. According to the CVM method, the morphology of the bodies of the second (C2), third (C3), and fourth (C4) cervical vertebrae are rated on a 6-level scale from cervical stage (CS) 1 to CS6:

CS1: The lower borders of all 3 vertebrae (C2-C4) are flat. The bodies of both C3 and C4 are trapezoid in shape.

CS2: A concavity is present at the lower border of C2. The bodies of both C3 and C4 are still trapezoid in shape.

CS3: Concavities at the lower borders of both C2 and C3 are present. The bodies of C3 and C4 may be either trapezoid or rectangular-horizontal in shape. The growth peak occurs the year after this stage.

CS4: Concavities at the lower borders of C2, C3, and C4 are present. The bodies of both C3 and C4 are rectangular-horizontal.

CS5: At least 1 of the bodies of C3 and C4 is square. If not square, the body of the other cervical vertebra is rectangular-horizontal.

CS6: At least 1 of the bodies of C3 and C4 is rectangular-vertical in shape.

STATISTICAL METHOD

All statistical analyses were performed with SPSS version 11.5. Spear man rank-order correlation coefficients were used to measure the association between the skeletal maturity and dental maturity of individual teeth, and the statistical significance of the correlation was tested.

RESULTS

Distribution of the chronological ages of the subjects according to cervical vertebra maturation indexes is shown in Table 1. In the first 5stages of the cervical vertebral maturity indexes, girls were younger than boys. In stage CS3, the mean chronologic age was 11.14 ± 1.46 years for girls and 12.5 ± 1.11 years for boys. There were no patients with CS6 stage in this study.

Spearman rank-order correlation coefficients between the cervical vertebral maturation stages and developmental stages for the 4 teeth are given in Table 2. All correlations between cervical vertebral and dental maturity stages were statistically significant ($P < 0.05$). The correlation coefficients ranged from 0.403 to 0.531 for girls and from 0.461 to 0.512 for boys. For girls, the tooth sequence in order from the lowest to the highest correlation was canine (0.403), first premolar (0.452), second premolar (0.508) and second molar (0.531). For

boys, the sequence was canine (0.461), second molar (0.491), first premolar (0.496) & second premolar (0.512).

The percentages of patients for the calcification stages and stages of CVM for each tooth are presented in Tables3-7. At CS1 (table 3), there was a wide variation in tooth calcification stages for all teeth in boys and girls. In both groups, the second premolar stage F had the highest percentage: 62.5% for boys and 50% for girls. In contrast, the second molar stage H had the lowest percentages: 0 for both girls and boys. At CS2 the lower second molar stage F had the highest percentages: 66.7% for girls and 66.7% for boys (Table 4).At CS4, the calcification of the canine was nearly complete. As listed in Table 6, stage H canines were present in 66.7% of girls and 62.5% of boys.

Most of the studied teeth were well formed by CS5. The canine stage H, first premolar stage H, second premolar stage H was highest in both genders 100% for girls 100% for boys in CS5 stage (Table 7)..

Table-1: Distribution of ages and genders (F/M) in the sample based on cervical vertebral maturity stages (CS).

CS	GENDER	n	AGE Mean ± S.D.
1	M F	06 08	9.16 ± 1.34 8.37 ± 1.57
2	M F	03 03	11.23 ± 0.44 10.34 ± 1.68
3	M F	06 06	12.5 ± 1.11 11.14 ± 1.46
4	M F	06 08	13.43 ± 1.35 12.5 ± 2.23
5	M F	02 02	16.03 ± 0.57 15.33 ± 0.47

Table-2: Spearman correlation coefficients between cervical vertebral and dental maturity stages *C,* Canine; *P1,* first premolar; *P2,* second premolar; *M2,* second molar.

	MALE		**FEMALE**	
	r	**P value**	**r**	**P value**
C	0.461	<0.01	0.403	<0.01
P1	0.496	<0.01	0.452	<0.01
P2	0.512	<0.01	0.508	<0.01
M2	0.491	<0.01	0.531	<0.01

Table-3: Percentage distribution of calcification stages of individual teeth at cervical vertebral maturity stage 1

Calcification stage	C M	F	P1 M	F	P2 M	F	M2 M	F
D	0	0	0	0	0	0	0	16.7
E	12.50	0	37.5	0	0	16.7	12.5	16.7
F	12.50	16.7	50.0	50.0	62.5	50.0	50.0	33.3
G	50.00	33.3	12.5	33.3	25.0	16.7	37.5	33.3
H	25.00	50.0	0.0	16.7	12.5	16.7	0	0

Table-4: Percentage distribution of calcification stages of individual teeth at cervical vertebral maturity stage 2

Calcification stage	C M	F	P1 M	F	P2 M	F	M2 M	F
F	33.3	33.3	33.4	33.3	33.3	33.3	66.7	66.7
G	33.4	33.3	33.3	33.3	33.3	33.3	33.3	33.3
H	33.3	33.4	33.3	33.3	33.3	33.3	0	0

Table-5: Percentage distribution of calcification stages of individual teeth at cervical vertebral maturity stage 3

Calcification stage	C		P1		P2		M2	
	M	F	M	F	M	F	M	F
E	0	0	16.7	0	16.6	0	0	0
F	16.7	16.7	16.7	16.8	16.7	33.3	66.7	50.0
G	33.3	66.7	33.3	50.0	50.0	50.0	33.3	50.0
H	50.0	16.6	33.3	33.2	16.7	16.7	6.0	0

Table-6: Percentage distribution of calcification stages of individual teeth at cervical vertebral maturity stage 4

Calcification stage	C		P1		P2		M2	
	M	F	M	F	M	F	M	F
E	0	0	0	0	0	0	12.5	0
F	12.5	16.7	25.0	33.3	25.0	33.3	25.0	33.3
G	25.0	16.6	37.5	33.4	37.5	33.3	37.5	50.0
H	62.5	66.7	37.5	33.3	37.5	33.4	25.0	16.7

Table-7: Percentage distribution of calcification stages of individual teeth at cervical vertebral maturity stage 5

Calcification stage	C		P1		P2		M2	
	M	F	M	F	M	F	M	F
G	0	0	0	0	0	0	50.0	50.0
H	100	100	100	100	100	100	50.0	50.0

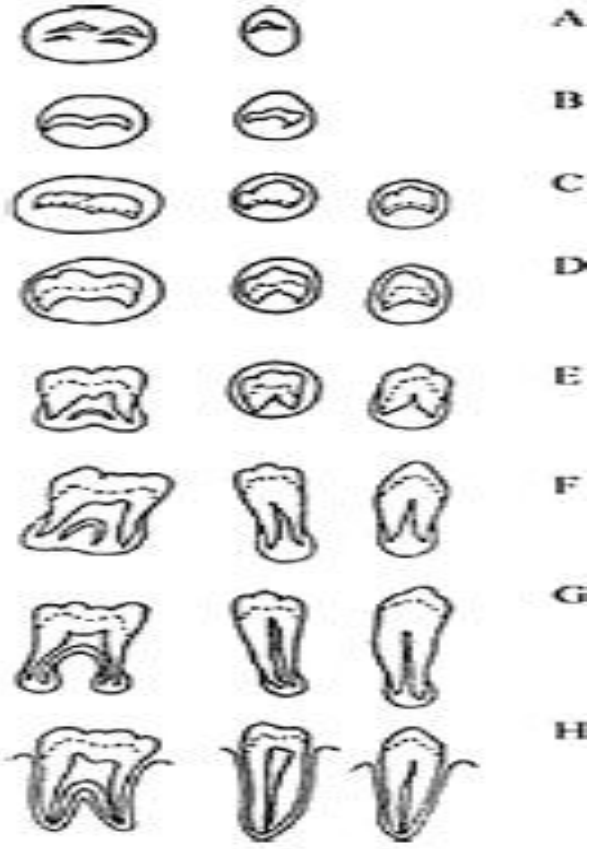

Fig-1: Dental Maturity Assessment

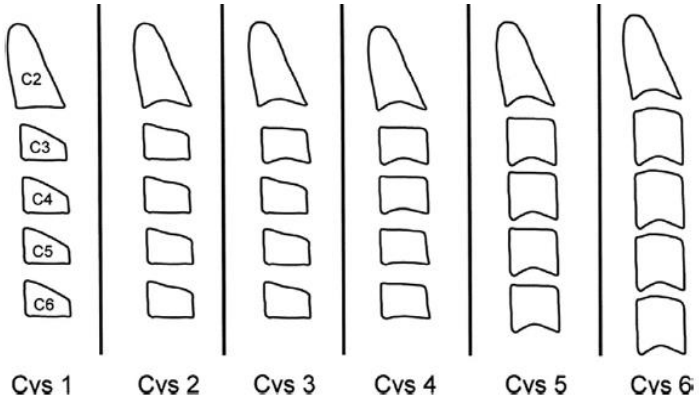

Fig-2: Skeletal Maturity Assessment

DISCUSSION

Over the period of time, dental age has been determined by various methods. The most commonly employed method uses time of eruption as a parameter. In the present study, we have employed calcification stages of teeth for determining the dental maturation. Various methods which employs measurements on radiographs as the basis for the determination the dental development uses many parameters such as tooth length, crown length, or the root length to indicate the dental age. In few methods, the ratio of the developed root to the definitive length of the root is used. However, the drawback of these methods is estimating a quarter or a third of an unknown root length. Therefore, this method was employed in this study. And due to the superimposition of anatomic structures, maxillary teeth were not considered in the study.

One of the main reasons behind increasing popularity of CVM is that excess radiation exposure to the patient can be avoided. As cervical vertebrae can be seen on lateral cephalograms which are commonly used in orthodontic diagnostics. According to the CVM method, CS1-CS2 indicates the period before the peak of growth; the pubertal growth spurt comes during CS3-CS4; and CS5-CS6 is the period after this peak.

According to Table-1 the chronological age distribution reveals that, in the first 5 stages of cervical vertebral maturity (CVS 1-CVS 5), girls were younger than boys. These results suggested with preceding studies.[18-25] Boys had a higher predilection toward late dental development in this study when compared to same cervical maturation stages.

A statistically significant correlation was observed between maturity stages of the examined teeth and skeletal maturity stages for both genders (Table 2). In the present study, the development of the mandibular second molar had the highest correlation coefficient with CVM stage among female subjects. This is in concordance with the previous studies done by Chen et al [22], Kumar et al [23] and Basaran et al [24].Some investigators have suggested that the development of the second premolar has the highest correlation with skeletal maturation [19,25] in girls.

In present study it was observed that for male subjects calcification of the mandibular second premolar had the closest relationship with CVM stage as in the previous studies done by Krailassiri et al [19]. However few studies [19,22] have also shown that the calcification of the mandibular canine had the highest correlation with CVM. The percentages for stage F were 33.3%-62.5% for CS1-CS2. In CS3 the percentages of stage G were 50%. For stage H, the percentages were 37.5%-100% for CS4-CS5. According to these results, a conclusion was substantiated that stage F of the second mandibular molar in women and stage G of the second mandibular premolar in men signify the initiation of the pubertal growth spurt in children of Kashmiri population.

CONCLUSION

In the present study among the studied group of subjects, the level of comparison among individual teeth was different was different: the teeth showing the highest correlation with CVM staging were the second molars in females and 2nd molars in males. The results confirm that both dental and skeletal maturity should be evaluated if the maturity stage of a growing child is relevant to clinical practice.

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