RESEARCH ARTICLE

A Study to Compare and Correlate the Status of Maturation in Growing Individuals Using Chronological Age Dental Maturation and Cervical Vertebrae Maturation

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Abstract

Aim and objective: To compare and correlate the status of maturation in growing individuals using orthopantomograph (OPG) and lateral cephalogram to establish a reliable relationship between chronological age (CA) and dental maturation (DM) with cervical vertebrae maturation index (CVMI).

Materials and methods: Lateral cephalometric radiographs and OPGs of 50 children within the circumpubertal period were collected (male n = 25, age 12–17 years, female n = 25, age 10–15 years) and evaluated for the status of maturation using CA, DM (of mandibular left canine and second molar using Demirjian Index-DI), and CVMI stages.

Results: Chronological age shows a positive correlation with CVMI stages in both groups. Gender-based association and distribution between DI stages of canine and CVMI stages shows that in both male and female sample groups DI G correlates with CVMI stage 1 and 2, DI H correlates with CVMI stage 3. Gender-based association and distribution between DI stages of 2nd molar and CVMI stages show that in the male sample group DI E shows a higher correlation with CVMI stage 1, DI F shows a higher correlation with CVMI stage 1 and 2. DI G shows a higher correlation with CVMI stages 2 and 3. DI H shows a higher correlation with CVMI stage 3. In the female sample group, DI F shows a higher correlation between CVMI stage 1 and 2, DI G and F show a higher correlation with CVMI stage 3.

Conclusion: Mandibular canine, second molar calcification stages, and CA show a positive correlation with CVMI stages in the present study, hence, this can be considered as a reliable indicator in skeletal maturity assessment.

Keywords: Cervical vertebral maturation, Chronological age, Dental calcification stages, Skeletal maturity.

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Introduction

Assessment of skeletal and dental maturation (DM) is a commonly applied approach in dental practice for growth modification.[1] Chronological age (CA) is the most easily determined parameter of all the developmental ages, and it can be calculated from the birthday of a child.

Skeletal maturation is commonly assessed in dentistry using hand-wrist radiographs and lateral cephalograms by visual inspection of the developing bones and their subsequent changes during ossification.[2] Hassel and Farman[3] in the year 1995 observed the shape changes of the cervical vertebrae with different stages of skeletal development. The cervical vertebral maturation can be evaluated on lateral cephalograms for growth prediction which avoids the requirement of additional radiographs for assessment of skeletal maturation.

The assessment of dental age is by identification of clinically present teeth and its comparison with eruption charts.[4] The limitations of this method include the influence of local factors, environmental factors, and variation in the timing of eruption. Hence, calcification stages of the teeth can be considered instead of eruption patterns.[5,6]

This study aims to compare and correlate the status of maturation in growing individuals using orthopantomograph (OPG) and lateral cephalogram to establish a reliable relationship between CA and DM with cervical vertebrae maturation index (CVMI) stages.

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Materials and Methods

A total of 50 lateral cephalometric radiographs and OPG's of subjects (25 males, 25 females) were randomly selected and analyzed.

Inclusion Criteria

- Male subjects of 12–17 years and female subjects of 10–15 years of same or near circumpubertal age group.
- The hard tissues were analyzed for their clarity in the OPG and lateral cephalogram.

- The interval between OPG and the lateral cephalometric radiograph does not exceed 30 days.
- Normal overall growth and development.
- No permanent teeth extracted.
- No history of orthodontic treatment.

Exclusion Criteria

- Systemic diseases.
- Abnormal dental conditions, such as impacted teeth, transpositions, and missing teeth.

Orthopantomograph's and Lateral cephalometric radiographs were used in this study and the following factors were evaluated.

Chronological age was calculated from the date of birth of the subjects included in this study.

Evaluation of DM was done on panoramic radiographs considering the calcification stages of mandibular left canine and second molar, according to Demirjian Index (DI).[5,6] The maturation status of the observing tooth was calculated from eight stages of calcification (A to H).

Evaluation of cervical vertebrae maturation on lateral cephalogram was done with Hassel and Farmans[3] method.

Mann–Whitney test was used to compare the mean age (in years) based on CVMI stages and age distribution among the subjects. Pearson contingency test was used to check the association and distribution between DI stages of 2nd molar and CVMI stages and also between DI stages of canine and CVMI stages among males and female subjects. $p < 0.05$ was kept as statistically significant.

RESULTS

Age distribution among the subjects shows a mean age of 13.48 ± 1.23 for male and 12.52 ± 1.19 for female subjects (p value < 0.02) (Table 1).

Gender-based association and distribution between DI stages of canine and CVMI stages using Pearson contingency test show that in the male and female sample group DI G shows a higher correlation with CVMI stages 1 and 2, DI H shows a higher correlation with CVMI stage 3 ($p < 0.002$) (Table 2).

Gender-based association and distribution between DI stages of 2nd molar and CVMI using Pearson contingency test show that in the male sample group DI E shows a higher correlation with CVMI stage 1, DI F shows a higher correlation with CVMI stage 1 and 2. DI G shows a higher correlation with CVMI 2 and 3. DI H shows a higher correlation with CVMI stage 3 ($p = 0.004$). In the female sample group, DI F shows a higher correlation between CVMI stage 1 and stage 2, DI G and F show a higher correlation with CVMI stage 3 ($p < 0.001$) (Table 3).

There was a positive correlation between CVMI stages and DI stages of mandibular left canine and second molar in both male and female groups as shown in Figures 1 to 4.

Table 1: Age distribution among study subjects using Mann–Whitney test

		Males		Females		
Variables	Categories	Mean	SD	Mean	SD	p value
Age	Mean and SD	13.48	1.23	12.52	1.19	0.02*
	Range	12–16		10–16		

*Statistically significant

Table 2: Gender-based association and distribution between DI stages of canine and CVMI stages using Pearson contingency test

		Stage G		Stage H			
Gender	CVMI	n	(%)	n	(%)	PCC value	p value
Males	Stage 1	7	100.0	0	0.0	0.57	0.002*
	Stage 2	10	90.9	1	9.1		
	Stage 3	2	28.6	5	71.4		
Females	Stage 1	4	100.0	0	0.0	0.58	0.002*
	Stage 2	10	100.0	0	0.0		
	Stage 3	4	36.4	7	63.6		

*Statistically significant
PCC value, Pearson contingency coefficient value; higher the PCC values, higher is the association between CVMI and DI stages

Table 3: Gender-based association and distribution between DI stages of 2nd molar and CVMI stages using Pearson contingency test

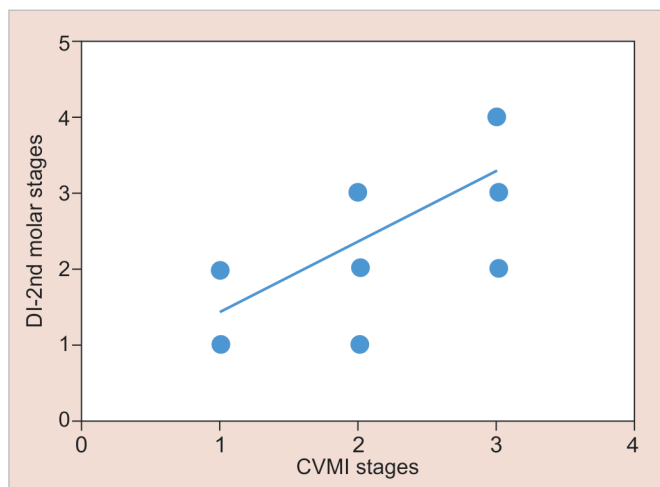|		Stage E		Stage F		Stage G		Stage H			
Gender	CVMI	n	(%)	n	(%)	n	(%)	n	(%)	PCC value	p value
Males	Stage 1	5	73.4	2	26.6	0	0.0	0	0.0	0.66	0.004*
	Stage 2	1	9.1	3	27.3	7	63.6	0	0.0		
	Stage 3	0	0.0	1	14.3	4	57.1	2	28.6		
Females	Stage 1	0	0.0	4	100.0	0	0.0	0	0.0	0.64	<0.001*
	Stage 2	0	0.0	8	80.0	2	20.0	0	0.0		
	Stage 3	0	0.0	0	0.0	9	81.8	2	18.8		

*Statistically significant

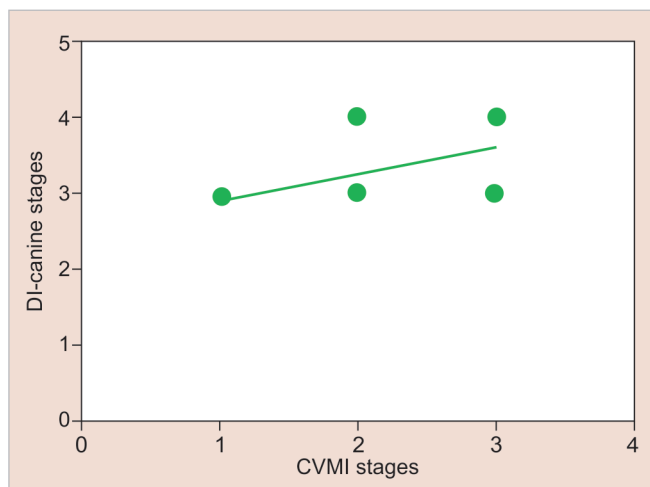**Fig. 1:** Positive correlation with CVMI stages and DI of 2nd molar in males

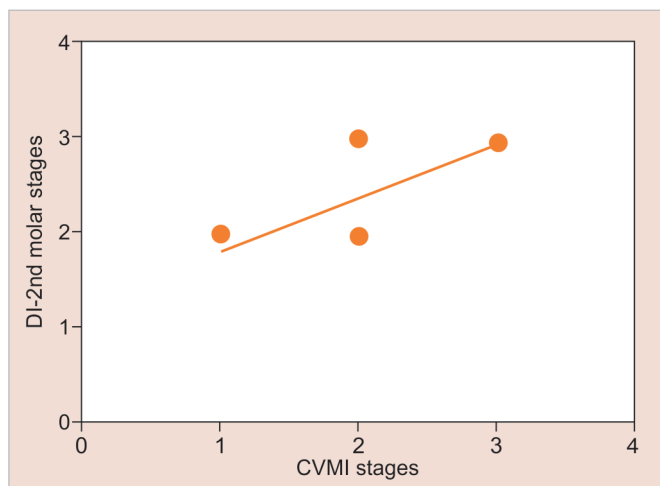**Fig. 2:** Positive correlation with CVMI stages and DI of canine in males

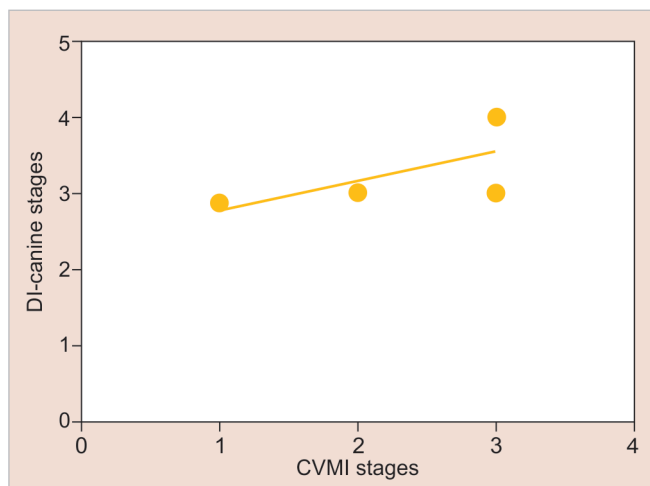**Fig. 3:** Positive correlation with CVMI stages and DI of 2nd molar in females

Fig. 4: Positive correlation with CVMI stages and DI of canine in females

Table 4: Comparison of mean age (in years) based on CVMI stages among males and females using Kruskal–Wallis test

CVMI	Males		Females		Mean diff.
	Mean	SD	Mean	SD	
Stage 1	12.29	0.76	11.00	0.82	1.29
Stage 2	13.36	0.67	11.90	0.57	1.46
Stage 3	14.86	0.90	13.64	0.51	1.22
p value	<0.001*		<0.001*		

*Statistically significant

Comparison of mean age and CVMI stages among males and females using the Kruskal–Wallis test shows a positive correlation. Mean age of 12.29 in males and 11 in females correlate with CVMI stage 1, that of 13.6 in males and 11.90 in females correlate with CVMI stage 2, 14.86 in males and 13.64 in females correlates with CVMI stage 3. The correlation was statistically significant among male and female subjects ($p < 0.001$) (Table 4 and Fig. 5).

DISCUSSION

This study was carried out to find the correlation between the CA, DM stages of mandibular left canine, and 2nd molar teeth with CVMI stages.

According to Nolla,[4] dental eruptions are reported to be more variable than the dental calcification stages. As dental eruptions are under greater environmental influence, in the present study,
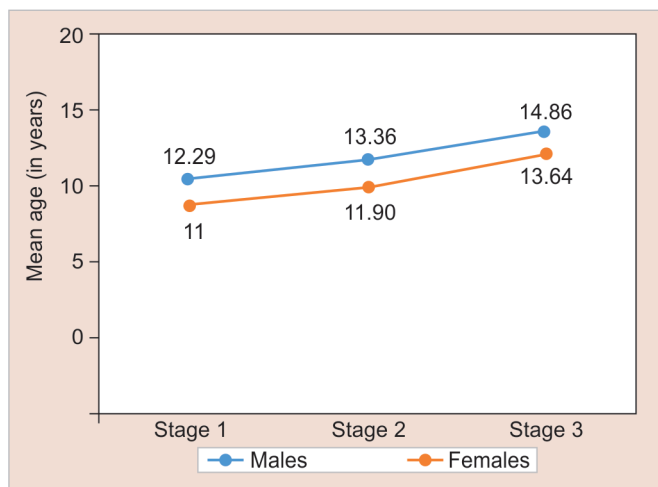
Fig. 5: Positive correlation with chronological age and CVMI stages

calcification stages (DI) of teeth instead of dental eruption stages were preferred.

As the onset of the circumpubertal periods between male and female subjects differ, certain age ranges of different sexes were selected to ensure selected subjects were in close or within the circumpubertal period.

A positive correlation between CA, DI of mandibular left canine and second molar with the CVMI stages was obtained in this study. The higher correlation obtained may be due to confining the correlation within the circumpubertal period.

Many studies were conducted to find out the correlation between skeletal maturity and the maturation of permanent dentition.[7] Demisch and Wartmann[8] found a high positive correlation, with a straight-line trend, between the degree of calcification of the mandibular third molar with the skeletal and CAs. Kumar et al.[2] also stated the significant association between DI of mandibular second molar and CVMI which supports the present study. Krailassiri et al.[9] concluded that the calcification stages of the mandibular second molar showed the highest correlation with a hand-wrist radiograph.

Lamons et al.[10] and Tanner[11] have reported insignificant correlations between skeletal and DM. This result is not in accordance with our study or previous studies mentioned, maybe due to different methods used for assessing skeletal and DM (used dental eruption pattern). A statistically significant correlation between dental calcification stages and skeletal maturity indicators was obtained in the findings of Krailassiri et al.[9] and Al-Balbeesi[12] which is in accordance with our study.

In our study, CA also showed a positive correlation with CVMI stages (Table 4). A study by Macha et al.[13] concluded that the correlation between chronological, dental, and skeletal age exhibited a statistical significance in both male and female subjects. But low correlations were found between the CA with both CVMI and hand wrist radiograph in Hessa Abdulla's[1] study. They concluded that CA was not a suitable indicator to measure skeletal maturity. Even though there are different results regarding the CA, we cannot avoid it fully as it is the simpler and easier method for assessing maturity.

Conclusion

- Mandibular left canine, second molar calcification stages, and CA show a positive correlation with CVMI stages in the present study, hence, this can be considered as a reliable indicator in skeletal maturity assessment.
- Assessment of dental development on OPG and prediction of skeletal maturation with it may reduce the need for additional radiographs and radiation exposure to the patient in regular dental practice. However, further study is recommended in a larger sample size and with broader age groups for more accurate results.

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