Original Article

Assessment of Skeletal Maturity by Using Mandibular Second Molar Calcification

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ABSTRACT

Objective: To correlate the mandibular second molar calcification stages as seen on OPG with CVM stages as seen on lateral cephalogram.

Study Design: Cross-sectional study.

Place and Duration of Study: This study was conducted at the Department of Orthodontics, Dental College HITEC-IMS, Taxilla Cantt from August 2021 to October 2021.

Materials and Methods: OPG and Lateral cephalograms of 100 patients reporting to department of Orthodontics for orthodontic treatment were evaluated and compared. SPSS software was used for statistical analysis. Spearman rank order correlation coefficient was calculated for determining the correlation between the two methods.

Results: A strong correlation (r =0.768) was found between CVM and DI stages. DI stage E was found corresponding to CS 1 and CS 2. Stage F corresponded to CS 2 (50.0%) and CS 3 (42.7%). Stage G corresponded to CS 3, 4 and 5. DI Stage H was found corresponding to CS 5 and CS 6 of the CVMI.

Conclusion: A strong correlation is found between DI stages of mandibular second molar and CVM stages. The mandibular second molar calcification stages can be utilized as a reliable indicator to assess skeletal maturity.

Key Words: DI stages, Orthopantomogram, Growing patients, CVM stages, Lateral cephalogram.

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INTRODUCTION

Successful diagnosis, treatment plan and treatment execution of a growing patient demands a thorough understanding of the concepts of growth and development. Age estimation of the patient plays a pivotal role in the inter-disciplinary treatment of orthodontics, pediatric and restorative dentistry, surgical management and dental implant placement. A variety of biological indicators can be used to study the skeletal maturity of an individual.[1] Teeth represent useful material for age estimation. Tooth calcification is known as a reliable criterion for dental age determination as it relies on distinct features of tooth morphology and it utilizes the ratio of root length and crown height.

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Demirjian et al introduced a method to determine the calcification stages and this method is in common practice these days.[2]

The correlation of tooth calcification stages with the skeletal maturity of an individual has been reported previously.[3–5] Perinetti et al[6] and Sukhia et al[7] have suggested that evaluating the dental maturation is helpful in diagnosing the pre-pubertal growth phase only but Toodehzaeim et al[8] have found it useful in diagnosis of the post-pubertal phase. on the other hand, concluded that tooth mineralization stages are helpful in diagnosis of both pre-pubertal as well as post-pubertal growth stages.[9]

Many studies have used mandibular canines[10], second premolars[11] or third molars[12] and evaluated correlation with skeletal age. On the other hand, literature has shown that mandibular second molar calcification stages are also reliable indicators to assess skeletal maturation.[13] This tooth can be preferred over other teeth as the course of its development is continued during the growth spurt period which is our focus of interest. With maxillary molars, estimation errors occur more frequently due to the overlap with other anatomic structures found in this region. This overlap presents difficulty in observing the maxillary molar roots.[14] Third molars are also not reliable for age assessment as they are known as the most common congenitally missing teeth.

The rationale of this study was to assess the level of skeletal maturity of an individual by observing the mandibular second molar calcification stages on panoramic radiograph which is one of the most commonly advised radiographs for orthodontic and restorative treatment, by evaluating its correlation with CVM stages as seen on Lateral cephalogram. In this way, one can assess skeletal maturation of patients without exposing the patients to un-necessary radiations in accordance with the ALARA principle.

MATERIALS AND METHODS

After approval from institutional Review Board (IRB), Lateral cephalometric radiograph of each patient reporting to the Orthodontic department for Orthodontic treatment were evaluated for CVM stages by two registrars to overcome observer bias. DI stages of mandibular second molar were evaluated on panoramic radiographs according to the method described by Demirjian et al. All the assessments were verified by a colleague and recorded on a performa**.**

Data Analysis: Statistical analyses were performed using the SPSS version 21.0. Quantitative variables like chronological age were calculated in means and standard deviation. Qualitative variables like gender, CVM stage, and mandibular second molar calcification stage were calculated in frequency and percentages. The relationship between mandibular 2nd molar calcification stage and CVM stage was found by calculating Spearman rank order correlation coefficient. Stratification was used to control the effect of modifiers such as age and gender. Post stratification chi-square was performed.

RESULTS

Total 100 patients with age ranging from 10 to 18 years (mean age 13.24 years) were included in this study. Frequency and percentages of both male and female patients were 50 (50.0%). Table 1 shows age distribution of the patients.

Table No.1: Age distribution of the patients

Age(years)	Frequency	Percentage
10-12	41	41
13-15	49	49
16-18	10	10
Total	100	100.0

Table No. 2: Correlation between CVM and DI stages

		Males		Females		Total	
		CVM Stage	DI Stage	CVM Stage	DI Stage	CVM Stage	DI Stage
Spear-man's Rho	Correlation coefficient	1.000	.821	1.000	.648	1.00	.768
	Sig. (2 tailed)		.000		.000		.000
	N	50	50	50	50	100	100

Table No.3: Association between CVM and second molar calcification stages

CVM Stage	DI stage E	DI stage F	DI stage G	DI stage H	Total
	Frequency(Percentage)				
CS 1	2(40.0%)	3(60.0%)	0(0.0%)	0(0.0%)	5(100.0%)
CS 2	6(30.0%)	10(50.0%)	4(20.0%)	0(0.0%)	20(100.0%)
CS 3	0(0.0%)	6(42.9%)	8(57.1%)	0(0.0%)	14(100.0%)
CS 4	0(0.0%)	4(25.0%)	10(62.5%)	2(12.5%)	16(100.0%)
CS 5	0(0.0%)	1(3.3%)	15(50.0%)	14(46.7%)	30(100.0%)
CS 6	0(0.0%)	0(0.0%)	4(26.7%)	11(73.3%)	15(100.0%)

Table No.4: Calculations of the associations between CVM and second molar calcification stages

		CS1	CS2	CS3	CS4	CS5	CS6	Chi Square
		Frequency(Percentage)						
Males	DI Stage E	2(40.0)	5(33.3)	0(14.3)	0(0.0)	0(0.0)	0(0.0)	64.93
	DI Stage F	3(60.0)	7(46.7)	2(28.6)	1(12.5)	0(0.0)	0(0.0)	
	DI Stage G	0(0.0)	3(20.0)	5(71.4)	6(75.0)	4(36.4)	0(0.0)	
	DI Stage H	0(0.0)	0(0.0)	0(0.0)	1(12.5)	7(63.6)	4(100.0)	
	Total	5(100.0)	15(100.0)	7(100.0)	8(100.0)	11(100.0)	4(100.0)	
Females	DI Stage E	0*	1(20.0)	0(0.0)	0(0.0)	(0.0)	0(0.0)	40.26
	DI Stage F		3(60.0)	4(50.0)	1(14.3)	1(5.3)	0(0.0)	
	DI Stage G		1(20.0)	4(50.0)	5(71.4)	11(57.9)	4(36.4)	
	DI Stage H		0(0.0)	0(0.0)	1(14.3)	7(36.8)	7(63.6)	
	Total		5(100.0)	8(100.0)	7(100.0)	19(100.0)	11(100.0)	
*No female subject was found having CS1.								

A strong correlation (r =0.768) between CVM and DI stages was found as shown in Table 2. A strong correlation (r =0.821) was found in males whereas a moderate correlation (r =0.648) was found in females as shown in Table 3. Table 3 shows the association between CVM and second molar calcification stages. DI stage E was found corresponding to CS 1 and CS 2 which signifies the pre–pubertal period. Stage F correlated with CS 2 (50.0%) and CS 3 (42.7%). Stage G corresponded to CS 3, 4 and 5. Stage H was found corresponding to CS 5 and 6 suggesting insignificant/no remaining growth.

Calculations of the associations between CVM and second molar calcification stages were separately performed for both genders to control the effect of gender (modifier) by stratification as shown in Table 4. Slightly more advanced dental maturation for the same CVM stage was found in males as compared to the females.

DISCUSSION

During a routine dental treatment, dental maturity as a method of growth evaluation offers an advantage of easy assessment. The use of specialized radiographs (hand-wrist radiographs) results in high radiation exposure time and dose which makes their use debatable keeping in view the ALARA principle. The fact that panoramic radiographs are easily available and that dental calcification stages are easy to appreciate makes it practical for resorting to assess skeletal maturity without advising any additional radiograph. Therefore, this study utilized the dental calcification stages described by Demirjian et al. This method involves evaluating the root lengths relative to crown height instead of focusing on their absolute lengths so that the reliability of this assessment is not affected by elongated or foreshortened projections of these teeth.

Correlation of tooth calcification stages with the skeletal maturity is reported to be high in many studies.[2,8,11,15,16–19] On the other hand, Perinitti et al[20] and Saglam et al[21] found low or insignificant correlations. Differences in the methods of evaluation may contribute towards this lack of agreement. Variability in the results may also be caused by age, number and racial background of the subjects which in turn are conditioned by factors such as climatic conditions, ethnicity, nutrition quality, socioeconomic background and level of industrialization.

Mithun et al[15] found a strong correlation (C*=0.851 for males and 0.882 for females) between DI and CVM stages. Results of this study support our findings (r = 0.821 for males) where as in contrast to this study, we found a moderate correlation in females (r= 0.648). DI stage E corresponded to CS 2 indicating pre–pubertal growth stage and DI stage F corresponded to CS 3 showing peak of pubertal growth spurt. DI stages G and H were associated with CS 4, 5 and 6 indicating end of pubertal growth.

In 2020, Toodehzaeim et al[8] found a strong correlation between the two parameters in Iranian population. The correlations were 0.819 for females and 0.805 for males which is comparable to our study. The males were in stage G and females were in stage F during the growth spurt stage. However according to this study, these stages are helpful in identifying the post pubertal growth phase only. Similar studies have been carried out in Pakistan by Kamal[19] and Raza et al[13] and the results in both the studies support our findings.

The findings of Sushil[1] et al and Uysal et al[22] indicated that with respect to the skeletal maturity stages, males tend to be advanced than females in tooth calcification. These findings are also consistent with our results. The results of this study are also in accordance to the previous study done by Surendran et al.[23] Thus DI stages are helpful in assessment of pre-pubertal and post-pubertal growth phases.

The results of this study cannot be generalized because of the small sample size and because of the single-institute nature of study. Moreover, the study did not aim to explore the reasons for the potential association between DI and CVM which remains a gap for future researchers. Although the distribution of sample was not even in different groups of DI and CVM, the valuable lessons learnt from this study might contribute towards minimizing the unwanted radiation exposure to the patients.

CONCLUSION

A strong correlation exists between mandibular second molar DI stages and CVM stages. The skeletal maturity of an individual can be assessed by means of mandibular second molar calcification stages.

Author's Contribution:

Concept & Design of Study:	Nazish Amjad
Drafting:	Muhammad Hasnain, Shahzonia Tariq
Data Analysis:	Haseeb Alamzeb, Mussab Irfan, Afshan Bibi
Revisiting Critically:	Nazish Amjad, Muhammad Hasnain
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Conflict of Interest: The study has no conflict of interest to declare by any author.

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