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ORIGINAL ARTICLE

Correlation between Mandibular 2nd Molar Calcification Stages and Cervical Vertebral Maturity Index (CVMI) among Southern Punjab Population

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ABSTRACT

Aim: To find out whether a correlation exists among the CVMI and dental calcification stages.
Study design: Case-control study
Place and duration of study: Department of Orthodontics, Nishtar Institute of Dentistry, Multan from 1st October 2020 to 30th April 2021
Methodology: One hundred and fifty orthopantomograms and lateral cephalograms patients were incorporated. The dental maturity was evaluated using8 stages of Demirjian index from stage A to H. This index is graded by determining the calcification stages of the left mandibular second molar tooth on an orthopantomogram. The CVM stages based on the morphology of 2nd, 3rd and 4th cervical vertebral bones on a lateral cephalogram, discern the skeletal maturity. This included 6 stages from stage 1 to 6, based on the depth of concavity and shapes of the vertebrae.
Results: The results showed a significant correlation amongst the dental calcification stages and CVMI, having a Pearson's correlation coefficient 'r' of 0.741. A gender dimorphism was observed with males showing more progressive dental calcification stages in the CVM stages 2 and 3 as compared to their female counterparts. The dental calcification stage 'D' correlates with CVM stage 1 which occurs approximately 2 years prior to adolescent growth spurt. CVM stage 3 i.e. peak of adolescent growth spurt conforms to dental calcification stage 'F' in females and stage 'G' in males. The dental calcification stage 'H' correlated with CVM stages 5 and 6 which indicate the cessation of growth.
Conclusion: The lower second molar tooth calcification stages are a valid measure of skeletal age and can be effectively utilized to estimate patient's age in orthodontic practice.
Keywords: Cervical vertebral maturation, Dental calcification, Mandibular 2nd molar, Skeletal maturity

INTRODUCTION

Assessment of the maturational status, to establish the adolescent growth spurt of the patient is imperative in the diagnosis of orthodontic cases and their treatment plan. The successful outcome of an orthopedic therapy is interdependent on skeletal maturity of an individual. At the same chronological ages children show substantial discrepancies in development. These differences in chronological and developmental age elicited the idea of employing physiologic age on the basis of degree of maturation of various organs and tissues. Henceforth a variety of biologic ages have been put forward in this regard. These include the morphological, dental and skeletal ages[1].

Hand-Wrist radiograph is foremost in evaluating skeletal maturity. Lately, alterations in the shape and size of cervical vertebrae have attained increased approval in individuals, who are growing, for skeletal maturity assessment, as it eliminates the requirement for an extra radiograph (Hand and Wrist) avoiding extra radiation exposure, keeping in mind the ALARA principle. It is implemented on lateral cephalogram, a standard radiograph used for diagnosis in orthodontics. Cervical vertebral maturation (CVM) method of Bacetti et al[2] is frequently used for skeletal growth analysis. It evaluates bodies of three cervical vertebrae (C2, C3 and C4) on a lateral cephalogram and is divided into 6 stages. Lately, various studies have presented that tooth calcification stages shown in panoramic radiograph can ascertain skeletal maturity in an individual. The Demirijan method is routinely utilized for this purpose.[3] A study conducted by Neeraj Kumar Das concluded a significant correlation amongst skeletal and dental maturity with value of 'r' reported to be 0.765.[4]

The rationale of this study is to discern correlation amongst dental calcification stages and CVMI.[5-9] This abolishes the need for an extra radiograph (Hand and Wrist) decreasing the radiation exposure to the patient. Moreover, there are no documented studies regarding correlation between dental and skeletal maturity among southern Punjab population of Pakistan. Keeping in view the regional dissimilitude, this study will help find correlation in our population so as to accurately assess the age of the patient and for more efficient treatment planning by bringing into play the growth of the patient. If a correlation exists between the two then the dental maturity can be fruitfully utilized to assess the degree of skeletal maturity in patients in future, imparting methodical evaluation of growth of the patient.

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MATERIALS AND METHODS

Two pre-treatment radiographs i.e. orthopantomogram and lateral cephalogram from each of the 150 patients (females=88, males=62), having age ranges between 9-19 years, who sought treatment from the Department of Orthodontics, Nishtar Institute of Dentistry, Multan were taken. Patients having healthy lower 2nd molar tooth and without previous history of trauma or surgery were incorporated in the study. All subjects gave a verbal informed consent. Patients having asymmetric faces, congenital malformations of the cervical vertebrae or any history of neck disorders such as tumors, infections etc. were excluded.

Fig. 1: Dental calcification stages

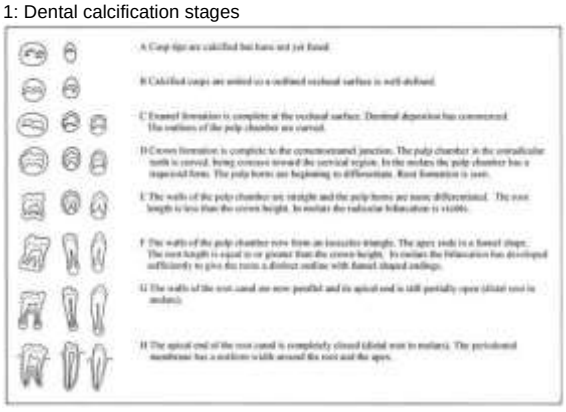
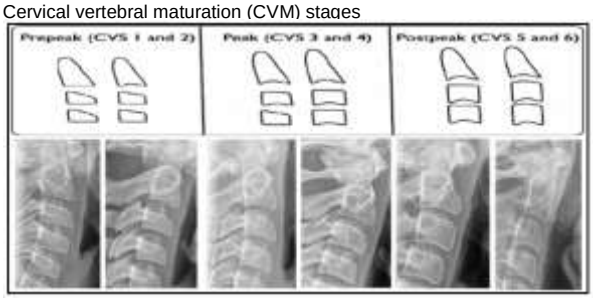


Fig. 2: Cervical vertebral maturation (CVM) stages



The skeletal maturational stages were observed from the lateral cephalogram, employing cervical vertebral maturation (CVM) stages of cervical vertebrae 2, 3 and 4, on the basis of their different morphologies. The appearance of a notch at the inferior borders of C2-C4 and the shapes and morphologies of the C3 and C4 either trapezoidal, rectangular horizontal, square or rectangular vertical were noted. This method as proposed by Bacetti et al includes six stages from CS 1 to CS 6.[2]

The tooth developmental stage of lower left second molar was analyzed on the orthopantomogram using the Demirjian index based on 8 stages from stage A to stage H.[3] To diminish the chances of error the radiographs were evaluated by 2 different persons. To find out if a correlation existed amongst the eight stages (A-H) of tooth development using Demirjian index (Fig. 1) and six stages (CS1-CS6) of skeletal maturity utilizing cervical vertebral maturation method by Bacetti et al (Fig. 2), distribution of dental developmental stages in the successive skeletal maturity stages of cervical vertebrae was calculated.[2,3] The data was entered and analyzed through SPSS-20. Pearson's correlation test was applied to estimate degree of association amongst the cervical vertebral maturation stages and the dental calcification stages of lower left second molar tooth. P value ≤ 0.05 was considered significant

RESULTS

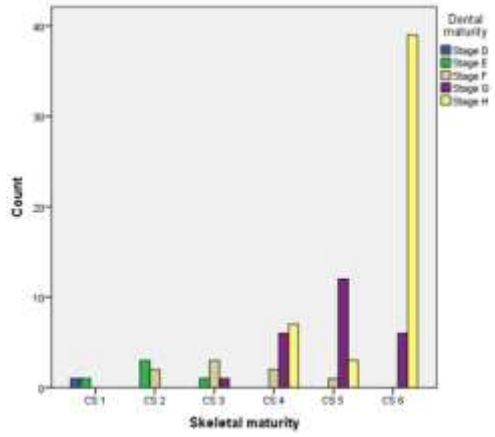
The correlation between the observed dental calcification stages and the cervical vertebral maturation stage was found to be significant having a Pearson's correlation coefficient 'r' of 0.741 (Table I).

Table 1: Correlation among dental and skeletal maturities (n=150)

Variable		Dental maturity	Skeletal maturity
Dental maturity	Pearson correlation	1	.741
	Sig.		.000
Skeletal maturity	Pearson correlation	1	.741
	Sig.		.000

Table 2: Correlation between dental and skeletal maturities according gender dimorphism

Gender	Value	Approx. Sig.
Male		
Pearson's R	.699	.000
Not valid cases	62	
Female		
Pearson's R	.809	.000
Not valid cases	88	



For males 'r' was 0.699 and for females it was 0.809 (Table 2). The cervical vertebral maturational stages were more advanced in females than their male counterparts. The dental calcification stages 2 and 3 were observed to be more in males than in females. The dental calcification stage 'D' correlates with CVM stage 1 i.e. pre-peak of adolescent growth spurt.CVM stage 3 i.e. peak of pubertal growth spurt, correlated with dental calcification stage 'F' in females and stage 'G' in males. The calcification stage 'H' correlated with CVM stages 5 and 6 which is post pubertal growth spurt i.e. the completion of growth.

Stages D, E, F, G and H represent stages of calcification of the left mandibular second molar as per Demirjian index while CS-1, CS-2, CS-3, CS-4, CS-5 and CS-6 are the stages of cervical vertebral maturity. The relation amongthe dental and skeletal maturity is shown in bar charts labeled as Figs. 1-3.

Fig. 1: Dental cacification stages along cervical cervicalvertebral maturation stages in females

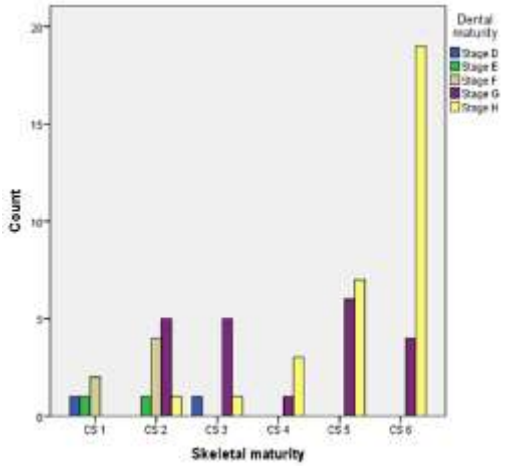


Fig. 2: Dental cacification stages along vertebral maturational stages in males

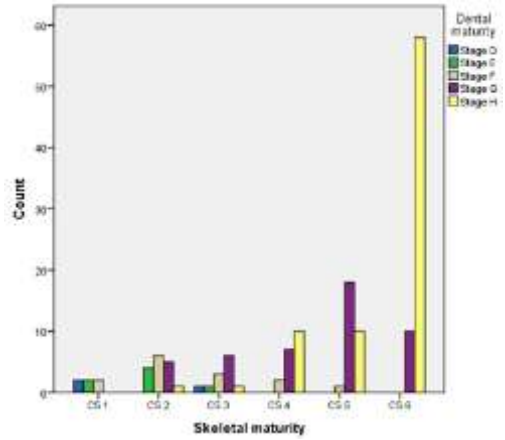


Fig. 3: Dental calcification stages along CVM stages in all subjects

DISCUSSION

Growth status of the patient is crucial for diagnosis and treatment planning in orthodontics.[5] Henceforth, different methods have been devised to ascertain the skeletal age of the patient. Dental calcification stages, CVM, hand and wrist radiograph are several methods used to evaluate skeletal age of patient. Panoramic radiograph is a routine radiographic modality used for diagnosis of orthodontic cases and the present study was conducted to discern if dental calcification stages could be utilized to estimate the skeletal age, annihilating need for an extra radiation exposure as per the ALARA principle.[6]

Multitudinous studies have been conducted to evaluate correlation between different skeletal age predictors.[7-17] The results vary from population to population thereby escalating the need for more research in individual populations. The current study was carried out to explicate the association between the lower second molar calcification stages and cervical vertebral maturation stages in patients of Southern Punjab population of Pakistan.

Madhusudhanan et al[1] in Kerala, India elucidated the correlation between stages of dental calcification using

Demirjian index and skeletal maturity using cervical vertebral maturation index. They found out a link between CVM stage 3 and dental calcification stage G in both males and females. Their results depicted minute disparity compared to the results of this study in which CVM stage 3 in females corresponded to dental calcification stage F whereas in males CVM stage 3 correlated with the dental calcification stage G which conform to the results of the aforementioned study.

A study conducted by Das et al analyzed the relation between dental and skeletal maturity.[4] A correlation was reported to be found between CVM stage 3 and the molar calcification stage E in the females and stage G in their male counterparts, which denotes the adolescent growth spurt. These results were different from the results of this study in which CVM stage 3, correlated with stage F in females and stage G in males.

Nizam et al studied the skeletal maturation using the mandibular second molar tooth calcification stages and found out that CVM stage 3 conformed to dental calcification stage F in both males and females which slightly differs from the results of this study according to which a correspondence exists between the CVM stage 3 and the dental calcification stage F in females and the stage G in males.[18]

Arvindhbhai et al studied whether a correlation exists between the skeletal and the dental maturity employing CVM and dental calcification stages, respectively. They studied both, the maxillary canine and the mandibular 2nd molar teeth to determine the dental calcification stages. The study concluded that stages E and F conformed to both the pre-pubertal and pubertal peak stages with male predilection (54.38%).[19]

A study conducted by Giri et al among Nepalese patients found out a correspondence of dental calcification stages F and G with CVM stages 3 and 4 in females whilst the males showed a correlation between dental calcification stage G and CVM stage 3 that are similar to the results of the current study.[20]

Divergence between the findings of various studies and this study is attributable to ethnic disparity, subjective assessment of dental calcification stages and dubious accuracy of cervical vertebral maturation stages. The findings of the current study state that the lower second molar tooth calcification stages, using the Demirjian index as viewed on the panoramic radiograph, are a valid measure of skeletal maturity and can be utilized to estimate the skeletal age of patient. More research should be carried out employing an increased number of patients.

CONCLUSION

The dental calcification stage D correlates with the CVM stage1 which is approximately 2 years prior to the peak of pubertal growth. The cervical vertebral maturation stage 3 conforms to the dental calcification stage F in the females and stage G in their male counterparts, which is the peak of adolescent growth spurt. The dental calcification stage H is correlated with the CVM stages 5 and 6, both of which indicate the completion of growth. The lower second molar calcification stages as estimated by the Demirjian index on an orthopantomogram, are an authentic measure of skeletal age and can be relied upon in formulating a comprehensive diagnosis and treatment plan.

Conflict of interest: Nil

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