International Journal of Medical Research Professionals

Original Article

Reliability of Dental Calcification Stages as Skeletal Maturity Indicator

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Article History
Received: 22 Jan 2016
Revised: 26 Jan 2016
Accepted: 28 Jan 2016

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ABSTRACT

Introduction: Growth being a multifactorial affair varies among individual of the same chronologic age. A perverted growth requires interception making the growth estimation essential.

Materials and Methods: The study sample was derived from lateral cephalogram and pantomogram, of 50 subjects in the age range from 7 to 20 years with a mean age of 12 years to correlate tooth calcification stages of mandibular canine, second premolar and second molar with the cervical vertebrae maturational stages.

Results: There was a strong correlation between the skeletal and dental maturity indicators. Mandibular second molar appeared to be the best predictor of maturational age.

Conclusion: Tooth calcification stages could be used reliably to estimate skeletal age.

KEYWORDS: Growth Modification, Skeletal Age, Tooth Calcification Stage.

INTRODUCTION

The maturational status and subsequent growth potential of an individual has a considerable influence on orthodontic diagnosis, treatment planning and the eventual treatment outcome, particularly for the orthopedic correction of skeletal malocclusions. Development as influenced both by genetic and epigenetic factors, is a racial, ethnic, climatic, nutrition and socioeconomic characteristic as well and therefore, varies among children of the same chronological age. As a result biologic age, which represents the degree of physiological maturation of an individual, is considered more reliable criteria.[1-6]

This can be estimated by somatic, sexual, skeletal, or dental maturity. Maturational status estimation using tooth and its correlation with the skeletal age has long been an area of interest to the researchers. The literatures available in this regard however, presented inconclusive results.[1,2]

The lack of harmony in this regard may be due to the difference in the methods of assessment. Tooth eruption is affected both by local and environmental factors making it untrustworthy for age estimation.[2]

Moreover, the ossification sequences and morphological changes in the skeleton have been shown to be a timed phenomenon and are closely associated with the pubertal growth spurt. Therefore, tooth calcification stages, are considered as a reliable criterion for determining dental maturation over the tooth eruption.[1-3]

The reason for evaluating the physiologic maturity using tooth calcification stages are – easy availability of routine dental radiographs and familiarity of the dental surgeons to the tooth morphology, as well as the, unacceptability of an additional radiographs (e.g. hand-wrist) from the radiation-hygiene, safety point of view.

Considering this, a study was conducted to assess dental maturation stages for determining skeletal age in north Indian population; with the aim to assess the reliability of tooth calcification stages as skeletal maturity indicator and to establish the relationship between the tooth calcification and cervical vertebrae maturation index.

MATERIALS & METHODS

This random retrospective cross-sectional study was conducted at the department of Orthodontics and Dentofacial Orthopedics at D. J. College of Dental Sciences and Research. The study sample consisted of lateral cephalometric and panaromic radiographs of 50 subjects in the age range from 7 to 20 years with a mean age of 12 years from the pre-treatment patient's record.

The criteria for inclusion were: 1.) No systemic disorder, and 2.) No missing teeth / history of trauma, injury, and impaction, till second molars.

Assessment of skeletal age

The morphologic characteristics of the cervical vertebra were evaluated from the lateral cephalograms to assess the skeletal age as explained by Lamparski and detailed by Hassel and Farman,[7] and was categorize into cervical vertebra stages (CVS) 1- CVS 6: (Fig-1-6)

- CVS 1 (Initiation stage): 80% to 100% of remaining pubertal growth was characterized by flat inferior vertebral body borders of C-2, C-3, and C-4, and tapered from posterior to anterior (wedge shape) superior borders.
- CVS 2 (Acceleration stage): showing 65% to 85% of remaining pubertal growth was characterized by the developing concavities in lower borders of C-2and C-3, flat lower border of C-4, and rectangular shape of C-3 and C-4.
- CVS 3 (Transition stage): showing 25% to 65% of remaining pubertal growth was characterized by distinct concavities in the lower borders of C-2 and C-3, developing concavity in the lower border of C-4 with a rectangular shaped of C-3 and C-4.
- CVS 4 (Deceleration stage): showing 10% to 25% of remaining pubertal growth was characterized by distinct concavities in lower borders of C-2, C-3, and C-4, and a nearly square shaped C-3 and C-4.
- CVS 5 (Maturation stage): showing 5% to 10% of remaining pubertal growth was characterized by accentuated concavities in the inferior vertebral borders of C-2, C-3, and C-4 with a square shaped C-3 and C-4.
- CVS 6 (Completion stage): showing completion of pubertal growth was characterized by deep concavities in the inferior vertebral borders of C-2, C-3 and C-4 and increased height of C-3 and C-4 compared to width.

Assessment of dental age

To evaluate the dental age, calcification stages of mandibular canine, second premolar and second molar was assessed using the panaromic radiographs. Tooth calcification stages were rated from A to H according to the method described by Demirjiyan.[1-3] (Fig A-H)

A: Calcified but non-fused cusp tips

B: United cusp tips forming occlusal outline

C: Enamel complete formed on the occlusal surface and commencement of dentinal deposition revealing curved outline of the pulp chamber

D: Crown formed till the cement-enamel junction with curved pulp chamber in uniradicular teeth and trapezoidal in molars. Differentiated pulp horns and commencement of root formation.

E: More differentiated pulp horns with straight pulp chamber. Bifurcation appearing in the molar region with root height less than crown height.

F: Pulp chamber in the isosceles triangle form and funnel shaped root apex with the root length equal to or greater than crown height. Developed bifurcation in the molars.

G: Parallel root canal walls with open apical end (in molars distal roots).

H: Completely closed apical end with uniform width of periodontal membrane around the root.

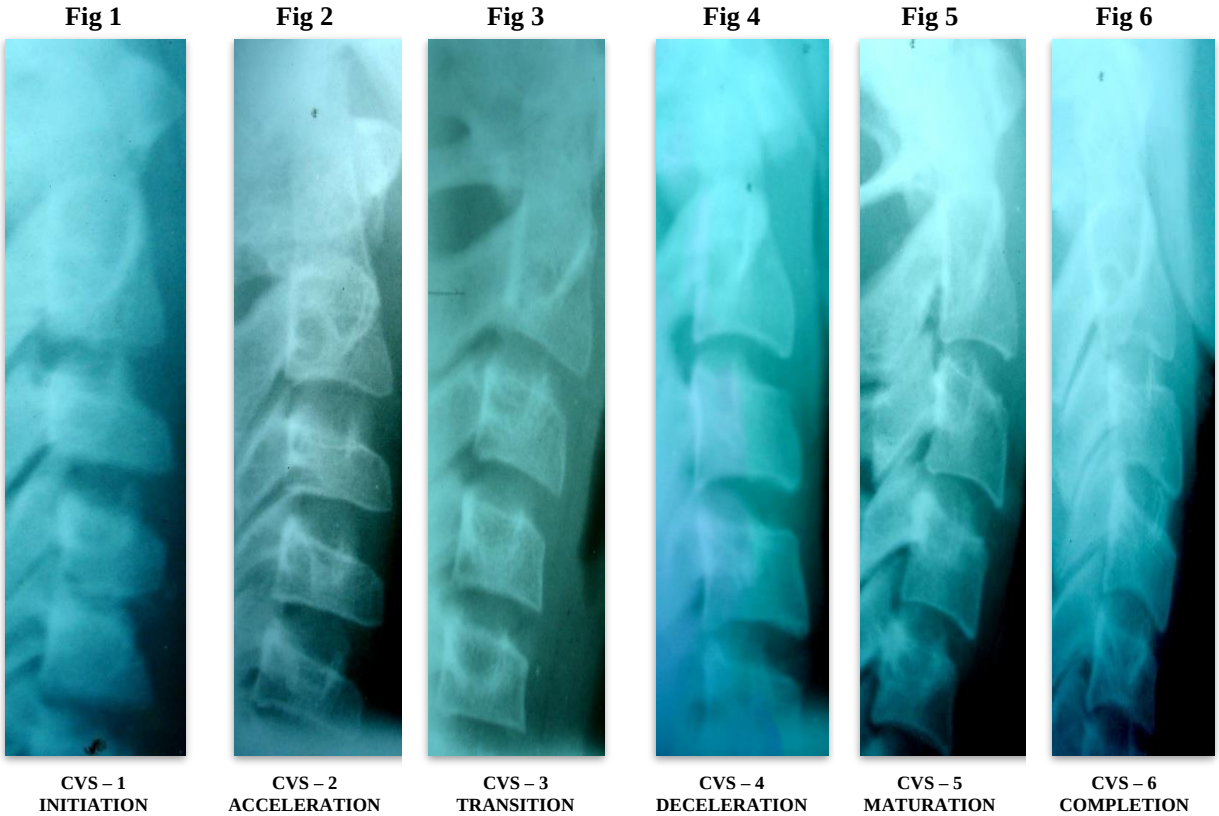


Fig - A

Cusp tips calcification

Fig - B

Cusp tips fused

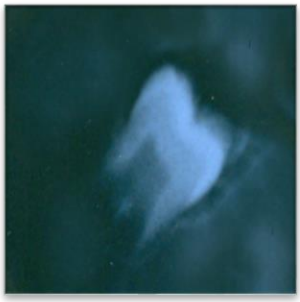
Fig - C

Occlusal surface completed

Fig - D

Crown formed till CEJ

Fig - E



Root length < crown height

Fig - F

Root length = /> crown height

Fig - G

Apical ends partially open

Fig - H

Root apex completely closed

Statistical analysis

All the data was tabulated and subjected to correlation coefficient test.

RESULTS

For the ease of calculation tooth calcification stage A-C was grouped together. CVS 1 correlated with tooth calcification stage E-F of canine, stage D-E of 2nd premolar and stage D of 2nd molar.

CVS 2 correlated with tooth calcification stage F-G of canine, stage E-F of 2nd premolar and stage D-E of 2nd molar.

CVS 3 correlated with tooth calcification stage H of canine showing apex closure at this stage, stage G-H of 2nd premolar showing apex has closed in a few cases and stage E-G of 2nd molar.

CVS 4 correlated with tooth calcification H of 2nd premolar showing apex closure at this stage, and stage G-H of 2nd molar showing commencement of apex closure.

CVS 5 correlated with tooth calcification stage H of 2nd molar showing apex closure at this stage.

CVS 6 all the tooth were in stage H. (Table 1)

The results of the study show positive correlation between cervical vertebral maturation and tooth calcification. The correlation coefficients were between 0.601 and 0.889 for both sexes. The significance level for all coefficients was the same from 0.601 to 0.889 for males and from 0.639 to 0.813 for females. (Table 2)

DISCUSSION

Growth and development is a timed and sequential phenomenon. Skeletal development, apart from the genetic control, is under the influence of various environmental factors.[2] Therefore; a variation from the normal always exists in nature, the severity of which may vary. A non-invasive way to correct and/or reduce the severity of these skeletal disharmonies requires an early diagnosis and intervention. The growth modification procedures correcting these skeletal imbalances prerequisites the patient to be in growing stage and the accurate timing of treatment varies for a particular condition, making the growth assessment at utmost important.[8-10]

There is a wide variation in the level of maturity amongst the genders as well as in individuals of the same sex for a particular age.[1-6] This difference in maturational status has call for a method for assessment of developmental age. Skeletal maturity has long been accepted to be a reliable method for the assessment of the physiological age.[1-4,7] Tooth formation and eruption being an orderly phenomenon, has also gained attention to be a maturity indicator.

The present study, has considered the tooth formation stages because tooth eruption is again a variable phenomenon and is affected by various local conditions. A second reason, for this is the familiarity of the dental surgeons to the tooth morphology and easy availability of the dental radiographs in the dental offices.

Previous studies have tried correlating tooth formation stages with different skeletal maturity indicators.[1-4] The growth and development being a racial and ethnic characteristic as well, warrants a study considering north Indian subjects.[1]

The present study has considered the calcification stages of mandibular canine, second premolar and second molar because the formation of these teeth stretches near the pubertal peak. Mandibular incisors and first molars were not considered because of their early apical closure. The maxillary teeth were not evaluated because of the superimposition of calcified structures in this area. The third molars were excluded from the study because of the variation in their anatomy and are often missing.

The present study, showed that the commencement of root formation to the 2/3 root formation of canine, crown completion to the starting of root formation of second premolar and the end of crown formation of the second molars correlated with the CVS 1 stage (Initiation stage) exhibiting 80% to 100% of pubertal growth. A stage of 2/3 root formation to the completely formed root with parallel canals of the canine, starting of root formation to the level where the root length of the premolar is greater than the crown for the premolars and end of crown formation to the initiation of root formation of the second molar correlated with CVS 2 (Acceleration stage), showing 65% to 85% of remaining pubertal growth. Apical closure of the canine, completely formed roots of the premolars with parallel canals and the stage of initiation root bifurcation to the stage open distal canals of the second molar correlated with the CVS 3 (Transition stage), exhibiting 25% to 65% of the remaining pubertal growth. From the stage of open apical end to the apex closure of the second molar correlated with CVS 4 (Deceleration stage), revealing 10% to 25% of the remaining pubertal growth. And when all the root apexes are closed till second molars, the shows CVS 5 (Maturation stage), exhibiting only 5% to 10% of the remaining pubertal growth.

The high correlation coefficient shows that the formation stages of the mandibular canine, second premolar and the second molar could be used as a predictor of the maturational status of an individual. This is in consonance with the previous studies conducted by Uysal T and coworkers using hand wrist radiographs on Tutkish population, Basaran G and coworkers on Turkish population using cervical vertebrae and Krailassiri S et al. on Thai population using hand wrist radiographs.

CLINICAL IMPLICATIONS

A high correlation of the tooth formation stages and the cervical maturation stages has opened a new vista for the general dentist and the pedodontists for early interception of the malocclusion and timely referral of the patient without an additional radiation burden.

CONCLUSION

A Dentofacial imbalance requires early diagnosis and timely intervention. The developmental age is a critical deciding factor for the commencement of treatment. Tooth formation stages could be used as an alternative to assess the maturational status of an individual.

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Cite this article as: Mukesh Kumar, Reena R. Kumar, Sommya Kumari. Reliability of Dental Calcification Stages as Skeletal Maturity Indicator. Int J Med Res Prof. 2016, 2(1); 141-44.