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# "Skeletal maturity assessment by comparing CVMI stages with calcification of maxillary canine, mandibular second molar and mandibular third molar- A RADIOGRAPHIC CEPHALOMETRIC STUDY"

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**Abstract**

**Aim and Objective:**

Orthodontic diagnosis and treatment planning for growing children must involve growth prediction, especially in the treatment of skeletal problems.The aim of this study was to correlate the growth phase of skeletal tissues with the calcification stages of maxillary canine, mandibular second molar and mandibular third molar.

**Materials and Methods:**

Anonymized digital Orthopantomogram and lateral cephalogram records of 50 pretreatment orthodontic patients aged 8–19 years were collected and analyzed. Right maxillary canine, mandibular second molar and third molar were used as a sample in accordance to the Gleiser and Hunt modified method of assessing tooth mineralization. The skeletal maturation was assessed by the cervical vertebrae maturation (CVMI) method by Baccetti et al.

**Results:**

A positive significant correlation was attained relating CVMI Stages 2,3 and 4 with calcification Stages maxillary canine, mandibular second molar and mandibular third molar.Conclusion: The calcification stages of maxillary canine, mandibular second molar and mandibular third molar can be implemented for assessing the skeletal maturity clinically. The canine calcification could be used as a sole indicator for assessment of skeletal maturity.

**KEY WORDS:** Canine calcification, growth prediction, CVMI, skeletal maturity index

## Introduction

Considerable variations in the development among individuals of the same chronological age have led to the concept of assessing biological or physiological maturity.The concept of physiological age is based upon the maturation degree of different tissue systems[1].

Chronological age is not more commonly use as skeletal maturity identification. In growing individual, orthodontic treatment depends on skeletal growth.To detect skeletal growth routinely hand-wrist radiograph should be taken which is a supplemental diagnostic aid apart from essential diagnostic radiographs such intra oral periapical radiographs, OPG, and lateral cephalogram. Several other markers have been investigated for their ability to estimate the overall physiological maturity of the individual. For that skeletal maturity indicators,

correlation with chronological age is considered acceptable.[3,4]

The ability to assess skeletal maturity by the developmental stage of the dentition through the examination of a panoramic radiograph (orthopantomograph) and relating them with CVMI from lateral cephalograms (both of which are routine diagnostic radiographs for orthodontic treatment) offers several advantages over the traditional hand-wrist radiographic method.

Generally, Orthodontists are more conversant in the panoramic radiographs and lateral cephalograms than with the hand-wrist radiograph.

Also, keeping in mind ALARA (As Low as Reasonably Achievable) principle, no additional exposure to radiation would be necessary if skeletal maturity are often accessed through routinely taken radiographs.

The relationship between skeletal maturity and the calcification of teeth for Indian children has not been established. Also the detection of skeletal growth of an individual through calcification stages of maxillary canine mandibular second and third molar is not yet established.There is limited information in literature regarding skeletal growth assessment by using OPG. Hence in this study an attempt was made to fill the lacunae regarding the skeletal growth assessment by using OPG & lateral cephalogram in children of Chattisgarh population.

**AIM**

The aim of this study was to correlate the growth phase of skeletal tissues with the calcification stages of maxillary canine, mandibular second molar and mandibular third molar.

**OBJECTIVES**

To provide an improved database to orthodontist to guage whether the calcification stages of maxillary canine, mandibular second molar, and mandibular third molar are often compared with CVMI for assessment of growth phase.

To give the patient reliable information with reference to percentage of growth remaining for orthopaedic changes which will be expected following the treatment.

**MATERIAL AND METHOD (fig 123)**

Anonymized digital Orthopantomogram (Fig 1) and Lateral cephalogram (Fig 2) records of fifty pretreatment orthodontic patients [27 girls and 23 boys] aged 8–20 years were collected and analyzed .

In OPG Right maxillary canine, mandibular second molar and third molar were used as a sample in accordance to the Gleiser and Hunt modified method of assessing tooth mineralization.

The inclusion within the study was set to incorporate only those individuals who presented with the subsequent criteria:

1.Chronological age starting from 8 to twenty years.
2.Free of any serious illness.
3.Normal overall growth and development
4.No abnormal dental condition, e.g. impaction, transposition and congenitally missing teeth.
5.No previous history of trauma or disease to the face & neck. Lateral ceps & OPG

**MATERIAL REQUIRED**

- 0.003” acetate tracing paper.
- 0.3 mm HB lead pencil. Geometry box (scale, protractor, set squares, eraser, sharpener).
- Scotch tapes

- Tracing board

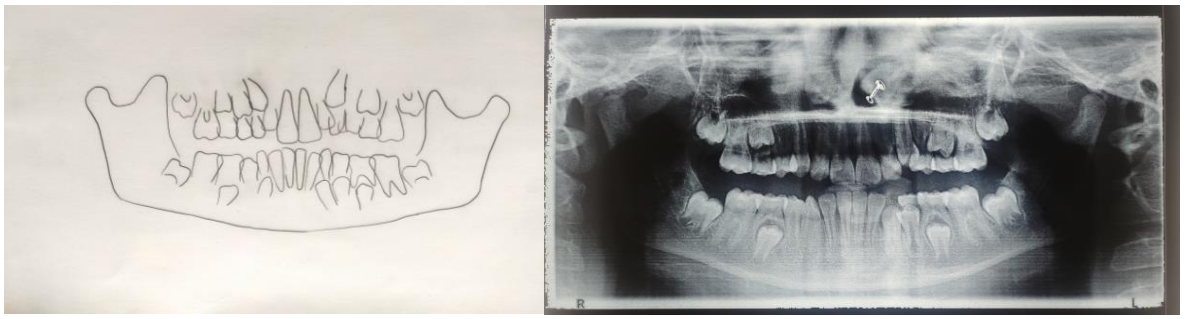


**Fig 1**- Orthopantomaogram showing Eruption of Teeth

**Fig 2** - Lateral Cephalogram showng CVMI Stages


**Fig 3 –** Tracing Materials

**METHOD**

The calcification stages of maxillary canine, mandibular second and third molars were evaluated. We elect the maxillary canines, because usually these teeth are the last teeth which erupt after the

loss of primary teeth within the upper arch and complete the amount of the mixed dentition. The maxillary canines should erupt at an equivalent time or a touch bit before the second molars. (Figure 5)

Mandibular second and third molars were included within the study because it had been easier to guage their radices within the panoramic radiographs and to work out their calcification stages. The skeletal maturation was assessed by the cervical vertebrae maturation (CVMI) method by Baccetti et al. (Figure 4)

Radiographic assessments of dental and skeletal maturity was performed simultaneously using an illuminated viewing box up a dark room .The most commonly used methods for growth evaluation are: the Somatic (based on the overall body changes alongside the event of the secondary sex characteristics) and therefore the Radiological ones (assessment of the hand-wrist radiographs or serial lateral cephalometric radiographs). (Figure 6)

Physiologic age is that the estimation of the particular rate of skeletal and somatic growth determined by the degree of maturation of various body parts

## STATISTICAL ANALYSIS

The aim of this study was to correlate the growth phase of skeletal tissues with the calcification stages of maxillary canine, mandibular second molar and mandibular third molar.

Correlation used=Spearman's rho

Software used=SPSS VAR00004=CVMI

VAR00005=DENTAL AGE (maxillary canine)

VAR00006= DENTAL AGE (mandibular second molar)

VAR00007= DENTAL AGE (mandibular third molar)

## RESULTS

The results of our study showed that maxillary canine, mandibular second molar and third molar had a high correlation with the cervical vertebrae maturation stages.

Our findings corresponded with the findings of other studies, that mineralization stage of the mandibular second molar was an honest predictor of skeletal maturity.

Furthermore, we found that calcification stages of mandibular second and third molars were good predictors of growth phase too and will be utilized in the clinical practice.

**Correlations**

| | | | VAR00004 | VAR00006 |
|---|---|---|---|---|
| Spearman's rho | VAR00004 | Correlation Coefficient | 1.000 | .709** |
| | | Sig. (2-tailed) | . | .000 |
| | | N | 50 | 50 |
| | VAR00006 | Correlation Coefficient | .709** | 1.000 |
| | | Sig. (2-tailed) | .000 | . |
| | | N | 50 | 50 |

**. Correlation is significant at the 0.01 level (2-tailed).

| **Correlations** | | | | |
|---|---|---|---|---|
| | | | VAR00004 | VAR00007 |
| Spearman's rho | VAR00004 | Correlation Coefficient | 1.000 | .756** |
| | | Sig. (2-tailed) | . | .000 |
| | | N | 50 | 50 |
| | VAR00007 | Correlation Coefficient | .756** | 1.000 |
| | | Sig. (2-tailed) | .000 | . |
| | | N | 50 | 50 |
| **. Correlation is significant at the 0.01 level (2-tailed). | | | | |

| **Correlations** | | | | |
|---|---|---|---|---|
| | | | VAR00004 | VAR00005 |
| Spearman's rho | VAR00004 | Correlation Coefficient | 1.000 | .603** |
| | | Sig. (2-tailed) | . | .000 |
| | | N | 50 | 50 |
| | VAR00005 | Correlation Coefficient | .603** | 1.000 |
| | | Sig. (2-tailed) | .000 | . |
| | | N | 50 | 50 |
| **. Correlation is significant at the 0.01 level (2-tailed). | | | | |

| **Correlations** | | | | | | |
|---|---|---|---|---|---|---|
| | | | VAR00004 | VAR00005 | VAR00006 | VAR00007 |
| Spearman's rho | VAR00004 | Correlation Coefficient | 1.000 | .603** | .709** | .756** |
| | | Sig. (2-tailed) | . | .000 | .000 | .000 |
| | | N | 50 | 50 | 50 | 50 |
| | VAR00005 | Correlation Coefficient | .603** | 1.000 | .449** | .530** |
| | | Sig. (2-tailed) | .000 | . | .001 | .000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | N | 50 | 50 | 50 | 50 |
| | VAR00006 | Correlation Coefficient | .709** | .449** | 1.000 | .650** |
| | | Sig. (2-tailed) | .000 | .001 | . | .000 |
| | | N | 50 | 50 | 50 | 50 |
| | VAR00007 | Correlation Coefficient | .756** | .530** | .650** | 1.000 |
| | | Sig. (2-tailed) | .000 | .000 | .000 | . |
| | | N | 50 | 50 | 50 | 50 |
| **. Correlation is significant at the 0.01 level (2-tailed). | | | | | | |

| CVMI STAGE | Calcification stage of Canine | Calcification stage of Mand Second Molar | Calcification stage of Mand Third Molar |
|---|---|---|---|
| Stage 1 | III | III | I |
| Stage 2 | IV | IV | II |
| Stage 3 | V | V | II |
| Stage 4 | V | VI | II |
| Stage 5 | V | VI | III |
| Stage 6 | V | VI | III |

**Table 1** Showing Correlation of maxillary canine, mandibular second molar and third molar with the Cervical Vertebrae Maturation Stages

## DISCUSSION

This concordance between teeth development and skeletal maturity could allow practitioners to use maxillary canines, mandibular second and third molars as an auxiliary manner to guage skeletal maturity stage in the growing patients from the panoramic radiographs.[5] Biologic age, skeletal age, bone age, and skeletal maturation are nearly synonymous terms wont to describe the stages of maturation of an individual. Due to individual variations in timing, duration and velocity of growth, skeletal age assessment is important in formulating viable treatment plans. Maturational status can have considerable influence on diagnosis, treatment goals, treatment planning, and the eventful outcome of orthodontic treatment. Clinical decisions regarding use of extraoral traction forces, functional appliances, extraction versus non extraction treatment, or orthognathic surgery are, atlest partially, based on growth considerations. Prediction of both the time and therefore the amount of active growth, especially within the craniofacial complex, would be useful to the orthodontist.

However, individual variations of tooth formation should be deliberated. The dental maturation stages of the mandibular teeth show satisfactory diagnostic performance just for the identification of the pre-pubertal and post-pubertal growth phases, with no reliable indications for the onset of the pubertal growth spurt. [6]

It is important to require under consideration, that different samples may influence the results of the correlation between the teeth and bone maturity, especially the third ones, as they're known for his or her many variations supported previous studies. [7, 8]

To conclude, it could be stated that assessment of maturation is of utmost importance in certain orthodontic protocols like for myofunctional therapy, before starting with rapid maxillary expansion and for timing of ortho-surgical procedures (surgery for mandibular setback should

carried out only after mandibular growth has completed).

To further validate the results of this study, it should be carried out on larger sample size and varied age groups.

**Figure 4.** Representation of the calcification stages for molars [5].

I—enamel formation is complete at the occlusal surface; dentinal deposition has commenced;

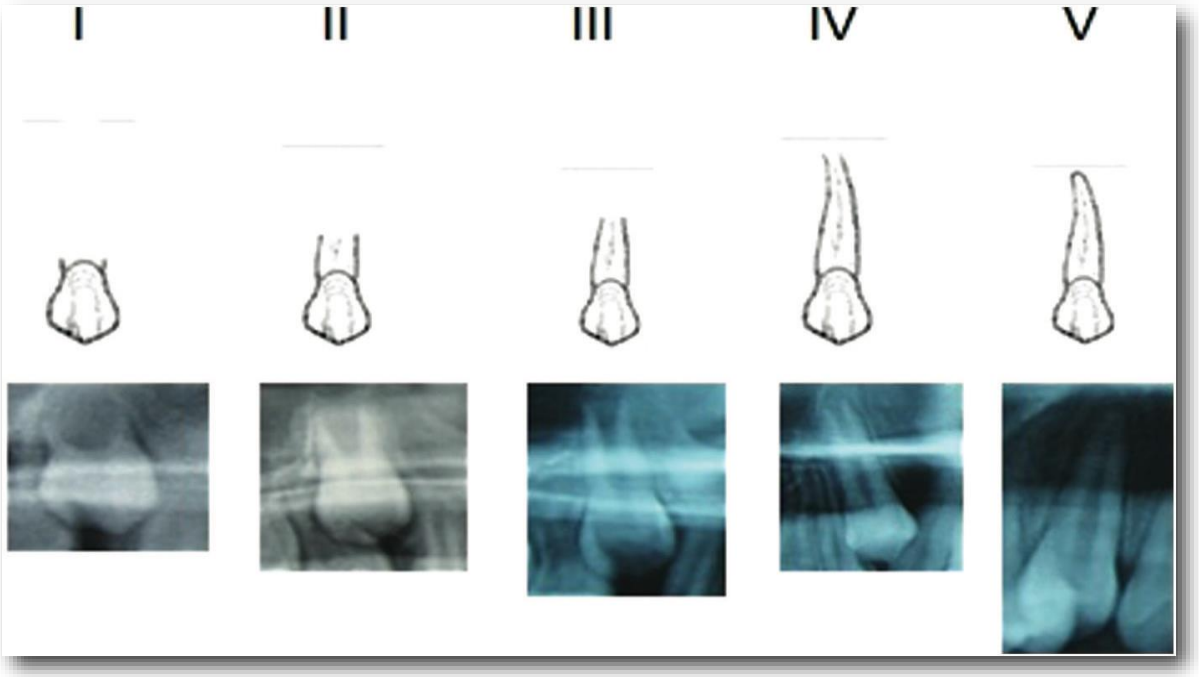
II—crown formation is complete to the cementoenamel junction;

III—walls of the pulp chamber are straight and the pulp horns are more differentiated; the root length is less than the crown height; radicular bifurcation is visible.

IV—root length is equal to or greater than the crown height; bifurcation is developed sufficiently to give roots a distinct outline with funnel shaped endings;

V—the walls of the root canal are parallel and apical end is still partially open;

VI—the apical end of root canal is completely closed; the periodontal membrane has an uniform width around the root and the apex.



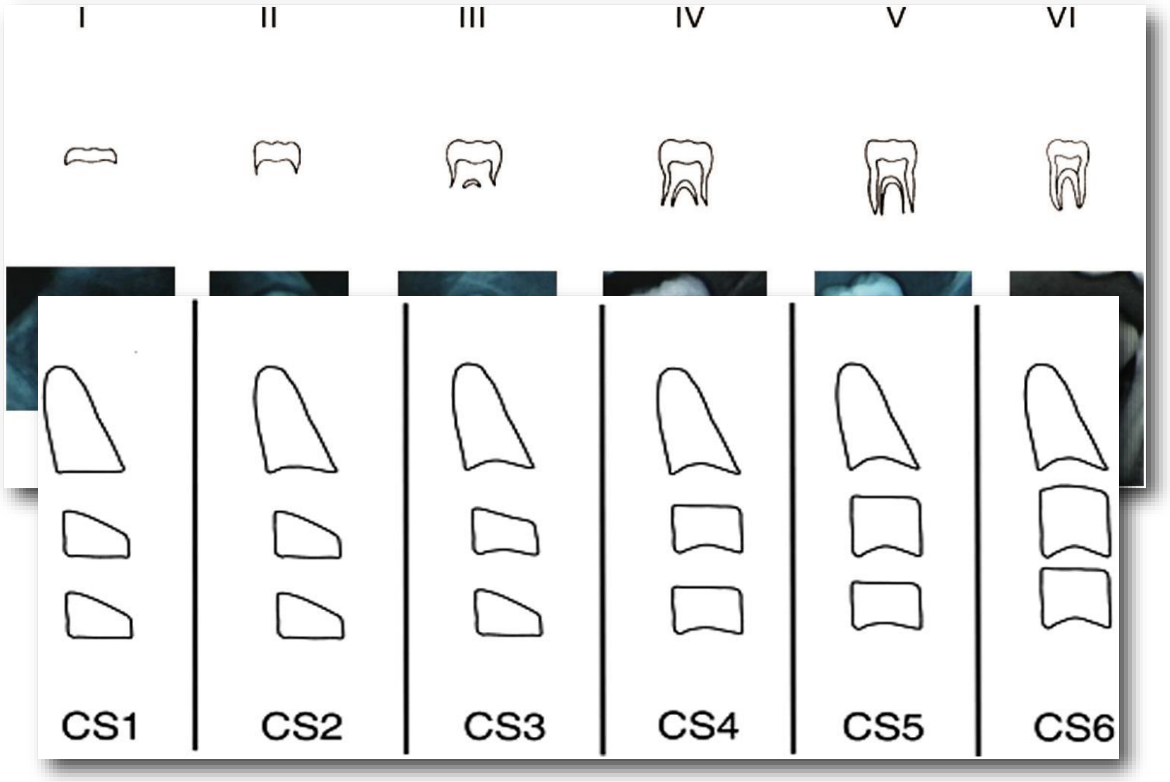



**Figure 5.** Representation of the calcification stage for canine.

I—crown formation is complete to the cementoenamel junction;

II—walls of the pulp chamber are straight and the pulp horn is more differentiated; the root length is less than the crown height.

III—root length is equal to or greater than the crown height; root with funnel shaped ending;

IV—the walls of the root canal are parallel and its apical end is still partially open;

V—the apical end of root canal is completely closed; the periodontal membrane has a uniform width around the root and the apex.

**Figure 6.** Morphologic features of vertebrae *C2* through *C4* [6].

CS-1—The lower borders of all three vertebrae (C2–C4) are flat. The bodies of C3 and C4 are trapezoid in shape.

CS-2—A concavity is present at the lower border of C2 in 80% of cases. The bodies of both C3 and C4 are trapezoid in shape.

CS-3—Concavities at the lower borders of both C2 and C3 are present. The bodies of C3 and C4 can be either trapezoid or rectangular horizontal in shape.

CS-4—Concavities at the lower borders of C2, C3, and C4 now are present.The bodies of C3 and C4 are rectangular horizontal in shape.

CS-5— The concavities at the lower borders of C2, C3, and C4 still are present. At least one body of C3 or C4 is square in shape. If not square, the body of the other cervical vertebrae still is rectangular horizontal.

CS-6—The concavities at the lower borders of C2, C3, and C4 still are present. At least one body of C3 or C4 is rectangular vertical in shape. If not rectangular vertical, the body of the other cervical vertebrae is square.

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