

# Radiographic Evaluation of Skeletal Maturity using Maxillary Canine and Mandibular Second Molar Calcification Stages in Western Maharashtra Population- A Retrospective Study

Savaliya Bhoomiben Arvindbhai<sup>1</sup>, Yusuf Ahammad A.R.<sup>2</sup>, Channamallappa R.G.<sup>3</sup>, Renuka Pawar<sup>4</sup>, Sandesh Phaphe<sup>2</sup>, Pratap Mane<sup>5</sup>

## ABSTRACT

**Introduction:** Assessment of skeletal maturity and dental development is a common clinical practice in orthodontics. Timing of the orthodontic growth modification therapy is typically linked with the individual's peak of skeletal maturity. No additional exposure to radiation would be necessary if skeletal maturity can be assessed through routinely taken panoramic radiographs.

**Material and Methods:** OPG and Hand-wrist radiographs of 114 children between 9 and 16 years of age were obtained from records of patients attending Dental Hospital, Maharashtra. Time- period for retrospective study between years 2012 to 2014. Demirjian method was used to estimate the dental age through assessment of different calcification stages of maxillary canine and Mandibular second molar. Skeletal stage was determined using Julian singer method by using hand-wrist radiographs.

**Results:** Paired T-test revealed no significant difference between mean dental and skeletal age. Tendency toward late skeletal maturation and early dental maturation was observed. Spearman rank order test showed high correlation between skeletal maturity markers and dental maturity markers of maxillary canine ( $r = 0.7386$ ) and mandibular second molar ( $r = 0.6109$ ).

**Conclusion:** Calcification stages of Maxillary canine and Mandibular second molar, there will be more chance for males than females to be within peak stages, this is because the maximum growth spurt in female occurs at earlier age than male.

**Keywords:** Orthopantomography (OPG), Demirjian Method (Dental Age), Hand Wrist, Julian Singer Method (Skeletal Maturation).

## INTRODUCTION

Growth and development of children is considered to be most important for orthodontist for age prediction which is known to vary between populations and can alter treatment planning. Physiologic age is the estimation of the actual rate of skeletal and somatic growth determined by the degree of maturation of different body parts.<sup>1</sup>

Chronological age is not more commonly use as skeletal maturity identification. In growing individual, orthodontic treatment depends on skeletal growth.<sup>2</sup>

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, correlat with chronological age is considered acceptable.<sup>3,4</sup>

Generally, the dental development can be assessed by either the phase of tooth eruption or the stage of tooth calcification, with

the latter being more reliable.

The ability to assess skeletal maturity by the developmental stage of the dentition through the examination of an OPG offers several advantages over the conventional hand-wrist radiographic method. In Orthodontic treatment most commonly using Orthopantomography than hand wrist radiograph. To reduce radiation exposer with children and skeletal maturity identification, several investigators have evaluated the association between dental maturity and chronological age in different populations.

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 and mandibular second 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 in children from Karad city.

## MATERIAL AND METHODS

Pretreatment OPG and Hand-wrist radiographs of 114 subjects [57 girls and 57 boys] were obtained from the records of patients who were seeking orthodontic treatment in Dental Hospital, karad.

OPG and Hand-wrist radiographs were graded according the Demirjian's tooth calcification stage and Julian Singer Hand-wrist radiograph stage. Radiographic assessments of dental and skeletal maturity was performed simultaneously using an illuminated viewing box in a dark room by trained oral radiologist. A single examiner performing dental and skeletal maturation assessment using OPG and hand-wrist radiographs.

The study protocol was reviewed and approved by the institutional ethical committee. The Inclusion criteria constitute: (1) children with normal growth and development within the age group of 9 and 16 years, (2) children with intermediate or

<sup>1</sup>Intern, <sup>2</sup>Reader, <sup>3</sup>H.O.D, <sup>4</sup>Professor, <sup>5</sup>Assistant Professor, Department of Orthodontics, School of Dental Sciences, Krishna Institute of Medical Sciences Deemed University, Karad, Maharashtra, India

**Corresponding author:** Ms. Bhoomiben Arvindbhai Savaliya, School of Dental Sciences, Krishna Institute of Medical Sciences Deemed University, Malkapur, Karad 415110, Maharashtra, India

**How to cite this article:** Savaliya Bhoomiben Arvindbhai, Yusuf Ahammad A.R., Channamallappa R.G, Renuka Pawar, Sandesh Phaphe, Pratap Mane. Radiographic evaluation of skeletal maturity using maxillary canine and mandibular second molar calcification stages in western maharashtra population- a retrospective study. International Journal of Contemporary Medical Research 2016;3(6):1750-1754.

late mixed, or early permanent phases of dentition. Children suffering from serious illness and systemic diseases were excluded from the study.

OPG and Hand-wrist radiograph were taken in single panoramic X ray a machine at the same time for each subject by keeping all the exposure parameters constant.

## METHODS

OPG and Hand -wrist radiograph of each individual was taken with a universal counter balancing type of cephalostat at the Dental Hospital, karad. Only in present study subject who takes Orthodontic treatment in Dental Hospital. Kodak' x-ray films used with a tube to film distance of 6 feet. Hand wrist radiograph taken with fingers slightly separated.

Any patients who presented congenital or acquired abnormalities of the phalanges were eliminated and interpretation of all radiographs were undertaken without referring to clinical data of age of patient.

Radiographic interpretation of this study was made through Julian Singer method for skeletal maturity indication and Demirjian method for tooth calcification stages indicator.

Calcification stage of Maxillary canine and Mandibular second molar are classified according to Demirjian method which include 8 stages of tooth calcification [A to H]. Hand- wrist radiograph were classified according to Julian Singer method divided into 6 stages [stage 1-6]. Both methods are commonly used because of their simplicity, popularity and reliability. OPGs were chosen for dental maturity assessment, as they are routinely available in orthodontic clinics, and the mandibular region is clearly visible.

### Assessment of individual dental maturity

Assessment of dental maturity was carried out through the calcification stages, according to Demirjian method(Stages D to H), in the OPG of the maxillary canine and mandibular second molar:

**Stage D:** Crown formation is complete down to the cemento-enamel junction and the beginning of root formation is seen, in the form of a spicule.

**Stage E:** Larger than that in the previous stage and the root length is less than the crown height.

**Stage F:** The root length is equal to or greater than the crown height.

**Stage G:** Apical end is still partially open.

**Stage H:** The apical end of the root canal is completely closed.

After assignment of a calcification stage for maxillary canine and mandibular second molar, stages were converted to scores through a conversion table, and then a score was calculated for each subject.

### Assessment of individual skeletal maturity

Julian Singer method for skeletal maturity identification in Hand-wrist radiograph. these stages are defined as:

Stage 1 (Early): Epiphysis of proximal phalanx of second finger being narrower than its diaphysis.

Stage 2 (prepubertal): Epiphysis of proximal phalanx of second finger is equal to its diaphysis in width.

Stage 3 (pubertal onset): Increased width of epiphysis of

proximal phalanx of the second finger.

Stage 4 (pubertal): Capping of the diaphysis of the middle phalanx of third finger by its epiphysis.

Stage 5 (pubertal deceleration): Fusion of epiphysis of distal phalanx of third finger with its shaft. Epiphyses of radius and ulna not fully fused with respective shafts.

Stage 6: Fusion of epiphysis of radius and ulna with respective shafts.

## STATISTICAL ANALYSIS

In this study we have to use Spearman rank correlation because it is a non-parametric test that is used to measure the degree of association between two variables. Spearman rank correlation test does not assume any assumptions about the distribution of the data and is the appropriate correlation analysis when the variables are measured on a scale that is at least ordinal and scores on one variable must be monotonically related to the other variable.

## RESULTS

Assessment of dental maturity was carried out through the calcification stages, according to Demirjian. Out of 57 boys, majority 44% of subjects shows stage E (Root formation has begun) at the age of 12 years, while in 57 girls, majority 33.33% of girl's shows stage G (Parallel root walls with open apices) at the age of 11 years. The Date of calcification is same for two teeth for particular period of growth and calcification stage advances in girl then boy at age between 11-12 years.

Table 1 and 2 Shows skeletal maturity according to Julian Singer Hand-wrist method in boys and girls. Correlation of maxillary canine root formation stage with hand wrist radiograph

54.38% of boys shows stage E (Root formation has begun) of maxillary canine same time, hand wrist radiograph shows stage 2(prepubertal), while 22.80% of girls shows stage G (Parallel root walls with open apices) of maxillary canine same time Hand wrist radiograph shows stage 3(pubertal onset), so we conclude that in boys stage E and in girls stage G shows peak stage of growth.

Table 3 and 4 shows correlation of mandibular second molar root formation stage with hand wrist radiograph in boys and girls.

42.10% boys shows stage E of mandibular second molar, same time hand wrist radiograph shows stage 2(prepubertal), while 22.80% girls stage E (root formation has begun) of mandibular second molar same time, Hand wrist radiograph shows stage 3 (pubertal onset).

## DISCUSSION

The present radiographic study represents a basic investigation to establish the relationship of maxillary canine and mandibular second molar root formation to growth status in a sample of Indian children.<sup>5</sup>

Chronologic age conveys only a rough approximation of the maturational status of a person, hence dental and skeletal ages have been explored as maturity indicators since decades. Assessing maturational status, can have a considerable influence on diagnosis, treatment planning, and the eventual outcome of orthodontic treatment. Growth modulation procedures which bring about changes in the skeletal base such as use of extra oral orthopaedic forces or functional appliances are based on active

Maxillary canine root formation	Hand wrist radiographic finding				
	Skeletal maturity staging				Total
	2	3	4	5	
<b>Boys</b>					
D	1(1.7%)	0	0	0	1
E	31(54.38%) **	3(5.26%)	0	0	34
F	0	1(1.7%)	0	0	1
G	4(7.01%)	13(22.80%)*	0	1(1.7%)	18
H	0	2(3.50%)	1(1.7%)	0	3
					57 Boys

( )percent distribution, \*\*Highly significant; r = 0.8364; \*considered significant at p- value <0.0001

**Table-1:** Shows skeletal maturity according to Julian Singer Hand-wrist method in boys

Maxillary canine root formation	Hand wrist radiographic finding				
	Skeletal maturity staging				Total
	2	3	4	5	
<b>Girls</b>					
D	1(1.7%)	2(3.50%)	3(5.26%)	7(12.28%)*	13
E	5(8.7%)	7(12.28%)*	1(1.7%)	1(1.7%)	14
F	1(1.7%)	2(3.50%)	0	0	3
G	1(1.7%)	13(22.80%) **	6(10.52%)	6(10.52%)	26
H	1(1.7%)	2(3.50%)	3(5.26%)	7(12.28%)*	13
					57 Girls

( )percent distribution, \*\*Highly significant; r = 0.8364; \*considered significant at p- value <0.0001

**Table-2:** Shows skeletal maturity according to Julian Singer Hand-wrist method in girls.

Mandibular second molar root formation	Hand wrist radiographic finding				
	Skeletal maturity staging				Total
	2	3	4	5	
<b>Boys</b>					
D	8	0	0	0	8
E	24(42.10%) **	3(5.26%)	0	0	27
F	2(3.50%)	1(1.7%)	0	0	3
G	2(3.50%)	14(24.56%)*	0	1(1.7%)	17
H	0	1(1.7%)	1(1.7%)	0	2
					57 Boys

( )percent distribution, \*\*Highly significant; r = 0.8364; \*considered significant at p- value <0.0001

**Table-3:** Correlation of mandibular second molar root formation stage with hand wrist radiograph in boys

Mandibular second molar root formation	Hand wrist radiographic finding				
	Skeletal maturity staging				Total
	2	3	4	5	
<b>Girls</b>					
D	2(3.50%)	1(1.7%)	0	0	3
E	4(7.01%)	13(22.80%) **	1(1.7%)	1(1.7%)	19
F	1(1.7%)	1(1.7%)	0	0	2(3.50%)
G	1(1.7%)	10(17.54%)*	7(12.28%)	9(15.89%)	27
H	0	0	2(3.50%)	4(7.01%)	6
					57 Girls

( )percent distribution, \*\*Highly significant; r = 0.8364; \*considered significant at p- value <0.0001

**Table-4:** Correlation of mandibular second molar root formation stage with hand wrist radiograph in girls.

growth periods.<sup>6</sup> This study help to determine growth potential in the adolescent patient with help of orthodontist and pedodontist. Because of individual variations on timing, duration and velocity of growth, skeletal age assessment is essential in formulating viable orthodontic treatment plans. Hand wrist radiograph most commonly used for skeletal maturity identification. To avoid taking an additional X-ray, however, some researchers have sought to relate maturation with dental and skeletal features.<sup>7</sup> Very few studies have shown that there is an association between bone development and different stages of dental calcification;

therefore, the stages of dental calcification can be used as the first tool for diagnosis. Dental maturity assessment offers the advantage (over skeletal maturity indicator) of being a simple procedure that can be carried out on panoramic and intraoral radiographs that provide minimal irradiation to the patient and easy determination of the calcification stages of teeth. On this basis, few researchers have proposed dental maturation to be a clinically useful diagnostic aid for the identification of individual skeletal maturation stages.<sup>8</sup> The Julian Singer method and Demirjian method seems to be highly practical for clinical use in skeletal age assessment and

tooth calcification assessment.

Mappes et al indicated that the predominant ethnic origin of the population, climate, nutrition, socioeconomic levels, and urbanization are causative factors of these racial variations. In normal child, the apex closure of Maxillary canine is completed by the age of 15 years, while Mandibular second molar extend up to 16 years.<sup>9</sup>

This makes the tooth more reliable as a maturity indicator since most children exhibit a period of active growth up to the age of 16-17 years, this is in agreement with the findings of Al-Bustani.<sup>5,10</sup>

No significant difference between chronological age and skeletal age assessed by SMI, similar findings were reported by Ha'gg.<sup>11</sup> But This is also not in accordance with some of the previous studies by Divyashree et al and Sahin Salam et al.<sup>12,13,7</sup> On comparing developmental stages of maxillary canine and mandibular 2<sup>nd</sup> molar in males and females, significant differences were found. Similar findings were reported by Hegde et al.<sup>14,12</sup>

Male patients shows stage E at the age of 12 years, while many of female patient's shows stage G at the age of 11 years.

Calcification stage of Mandibular second molar there will be more chance for males than females to be within peak stages, this is because the maximum growth spurt in female occurs at earlier age than male, which turn to affect the skeletal maturation more than the dental development. Our study also shows same results.<sup>15</sup>

On comparing developmental stages of maxillary canine, In Female stage G of maxillary canine coincides with stage 3 of Hand wrist radiograph, while in Male stage E coincides with stage 2 of SMI (Table 1 and 2). These stages represent the peak of the pubertal growth spurt. This finding supports the suggestions of previous studies.

The present study revealed a highly significant association between the developmental stages of mandibular 2<sup>nd</sup> molar and SMI, stage E coincides with stage 3 of SMI in females and stage 2 in Males (Table 3 and 4).

In panoramic radiographs, tooth calcification stages clinically useful for skeletal maturity indicator at the period of pubertal growth.

The ability to accurately appraise skeletal maturity from maxillary canine and mandibular second molar calcification, without the need for additional radiographs, has the potential to improve orthodontic diagnostic and therapeutic decisions. The hand wrist radiograph should be seen as a complement, rather than a replacement, to other valid methods to evaluate a child's physical condition. The techniques simplicity and ease of use should encourage these methods as first level diagnostic tool to assess skeletal maturity. Therefore, it is practical to consider the relationship between dental and skeletal maturity when assessing age of an individual in the age group of 8-16 years. There are remarkable differences in the distribution of tooth calcification and mineralization phases between sexes. Girls usually begin and end their dental development earlier than boys. Clinically, these differences suggest the need to start orthodontic treatment earlier in girls than in boys.

## CONCLUSION

Calcification stages of maxillary canine and mandibular second

molar can give a guide for the puberty period, in stage D all males and females are in pre peak stage, in stage E and F they are within pre-peak and peak stages with more male(54.38%) than female maturity. In stage G, males in peak stage, whereas about one third of females(22.80%) passed to post peak, in stage H, less than 10% of males passed to post peak, while 80% of females are within post peak stage.

The apex closure of Maxillary canine is completed by the age of 15 years, while Mandibular second molar extend up to 16 years.<sup>9</sup> Calcification stages of this two teeth, there will be more chance for males than females to be with in peak stages, this is because the maximum growth spurt in female occurs at earlier age than male.

The findings of this study indicate that tooth calcification stages might be clinically used as skeletal maturity indicator at the period of pubertal growth.

## REFERENCES

1. Sachan K, Sharma VP, Tandon P. A correlative study of dental age and skeletal maturation. *Indian J Dent Res.* 2011;22:882.
2. Pradeep Raghav, Akshi Rathee, Vaibhav Misra, Munish Reddy C, Shishir Singh, Ajay Yadav. An in-vitro comparison between hand wrist ossification and mandibular second molar calcification as a maturity indicator. *Annals of Dental Specialty.* 2014;2:124-128.
3. Morris JM, Park JH. Correlation of dental maturity with skeletal maturity from radiographic assessment: A review. *J Clin Pediatr Dent.* 2012;36:309-14.
4. Mittal S, Singla A, Viridi M, Sharma R, Mittal B. Correlation between determination of skeletal maturation using cervicalvertebrae and dental calcification stages. *Internet J ForensicSci.* 2011;4:1-8.
5. Al-Bustani A. Application of peri-apical radiographic view of four mandibular permanent teeth in orthodontic diagnosis. *J Bagh Coll Dentistry.* 2011;23:94-9.
6. Kraiassiri S, Anuwongnukroh N, Dechkunakorn S. Relationships between Dental Calcification Stages and Skeletal Maturity Indicators in Thai Individuals. *Angle Orthod.* 2002;72:155-166.
7. Goyal S, Goyal S, Gugnani N. Assessment of skeletal maturity using the permanent mandibular canine calcification stages. *J Orthod Res.* 2014;2:11-6.
8. Malik P, Rana V, Rehani U. To Evaluate the Relationship between Mandibular Canine Calcification Stages and Skeletal Age. *Int J Clin Pediatr Dent.* 2012;5:14-19.
9. Mappes MS, Harris EF, Behrents RG. An example of regional variation in the tempos of tooth mineralization and hand-wrist ossification. *Am J Orthod Dentofacial Orthop.* 1992;101:145-151.
10. Hayder F. Saloom. Detection of skeletal maturity using periapical radiographs. *J Bagh College Dentistry.* 2011;23:155-161.
11. Ha'gg U, Taranger J. Maturation indicators and the pubertal growth spurt. *Am J Orthod.* 1982;82:299-309.
12. Divyashree R, Dinesh M, Amarnath B. Reliability of PermanentMandibular Canine Calcification as an Indicator of SkeletalMaturity in Karnataka Population. *World Journal of Dentistry.* 2010;1:7-11.
13. Sahin Salam AM, Gazilerli U. The relationship between dental and skeletal maturity. *J Orofac Orthop.* 2002;63:454-62.
14. Reshma Nayak, US Krishna Nayak, Gautam Hegde

- Assessment of Growth Using Mandibular Canine Calcification Stages and Its Correlation with Modified MP3 Stages. *International Journal of Clinical Pediatric Dentistry*. 2010;3:27-33.
15. Kumar S, Singla A, Sharma R, Viridi MS, Anupam A, Mittal B. Skeletal maturation evaluation using mandibular second molar calcification stages. *Angle Orthod*. 2012;82:501–506.
  16. Nolla CM. The development of the permanent teeth. *J Dent Child*. 1960;27:254–263.
  17. Garn SM, Lewis AB. The relationship between the sequence of calcification and the sequence of eruption of the mandibular molar and premolar teeth. *J Dent Res*. 1957;36:992–995.
  18. Fanning DA, Brown T. Primary and permanent tooth development. *Aust Dent J*. 1971;16:41–43.
  19. Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. *Hum Biol*. 1973;45:211–227.
  20. Acheson RM, Vicinus JH, Fowler GB. Studies in the reliability of assessing skeletal maturity from x-rays. Part III. Greulich-Pyle atlas and Tanner-Whitehouse method contrasted. *Hum Biol*. 1966;38:204–218.
  21. Cole AJ, Webb L, Cole TJ. Bone age estimation: a comparison of methods. *Br J Radiol*. 1988;61:683–686.

**Source of Support:** Nil; **Conflict of Interest:** None

**Submitted:** 22-04-2016; **Published online:** 30-05-2016