

## ORIGINAL ARTICLE

### Evaluation of relationship between chronological age, dental age and skeletal age by using ossification of middle phalanx of third finger: An original research

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#### ABSTRACT:

**Background:** Investigators have proven that significant changes occur during puberty which can be seen by different skeletal maturity indicators. However, the available literature has little documentation on the changes occurring in boys and girls during puberty. Therefore, the purpose of the present clinical study is to evaluate and compare skeletal age, dental age and chronological age to find out which one is the good predictor of skeletal maturation and to find out at what age pubertal spurt occurs in boys and girls from Pimpri-Chinchwad area. **Material & Methods:** A questionnaire study was carried in the department of Paediatric and Preventive Dentistry. A total number of 80 children were provided with the questionnaire. This questionnaire was used for further evaluation in the study as a data source. Age group from 8-15 years both males and females were included in this study. 80 children were included in this study. Inclusion were Boys and girls of this study were domicile of Pimpri-Chinchwad area. **Results:** The study consisted of a total number of 80 participants of whom 43 (53.75%) were males and 37 (46.25%) were females. The mean of the study participants was  $11.34 \pm 2.43$  years. Among males 9.3 % (n= 4) were at the F Stage, 18.6 % (n=8) at FG stage, 23.3 % (n=10) at G stage, 25.6 % (n=11) at H stage and 23.3 % (n=10) were at I stage of ossification of middle phalanx of third finger (MP<sub>3</sub>). Among females 16.2% (n=6) were at F stage, 5.4%(n=2) at FG stage, 29.7% (n=11) at G stage, 21.6 % (n=8) at H stage and 27.0%(n=10) were at I stage of ossification of middle phalanx of third finger (MP<sub>3</sub>). There was no statistically significant difference at each group according to Hagg and Taranger in between the males and females using Mann Whitney U test (p value = 0.847). **Conclusion:** The correlation between chronological age, dental age and skeletal age was significant according to the result. Thus, chronological age can be used to estimate dental age, dental age can be used to estimate skeletal age and skeletal age can be used to estimate chronological age in children from Pimpri-Chinchwad population.

**Key words:** Chronological Age, Dental Age, Skeletal Age, Middle Phalanx, Third Finger

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#### INTRODUCTION

Assessing maturational status, whether the pubertal growth spurt has been reached or completed can have a considerable influence on the diagnosis, treatment goals, treatment planning and the eventual outcome of preventive and interceptive treatment in a child. This is especially true when clinical considerations of a child are based strongly on the increased or decreased rates of craniofacial growth, such as the timing and use of preventive and interceptive orthodontics. The use of functional appliances, extraction versus non extraction orthodontic treatment, the selection and execution of orthodontic retention and the timing of

orthognathic surgery. Every skeletal and muscular dimension seems to be involved in the pubertal growth spurt. The pubertal growth spurt is considered to be an advantageous period for certain types of orthodontic treatment and should be taken into account in connection with orthodontic treatment planning. Stature is not an indicator of maturity. Thus, additional information is necessary to estimate the maturation level of the individual. Such information can be obtained from dental, skeletal and pubertal development. By comparing with standards for age and sex, it is possible to assess whether the development of individual is average, accelerated or

retarded. In orthodontics it is more relevant to evaluate the individual maturation in relation to his or her own pubertal growth spurt. This presupposes knowledge of relationship in time between maturation indicators and pubertal growth events. Suitable maturation indicators for clinical orthodontics have been devised, and the associations between these indicators and the peak of growth have been reported<sup>1</sup>. Dental maturity can be determined by the stage of tooth eruption or by the stage of tooth formation. Tooth formation is proposed as a more reliable criterion for determining dental maturation. The ease of recognition of dental development stages, together with the availability of dental development stages, and also the availability of periapical or panoramic radiographs in most orthodontic or pediatric dental practices are practical reasons for attempting to assess the physiologic maturity without restoring to hand-wrist radiographs<sup>2</sup>. But these methods unnecessarily exposes the child to radiation for just assessment of maturity. In the literature, little is known about the relationship between the onset of puberty and dental maturation. Some studies have shown that correlation between tooth mineralization and other parameter of physical development are generally low<sup>3</sup>. Whereas there is little more than slight co-variation between tooth eruption and the adolescent growth spurt. Human growth shows considerable variation in the chronologic ages at which individual children reach puberty. Developmental status of a child is best estimated by relative to specific stages of physiologic maturity<sup>4</sup>. It is presently agreed that some general factors of body maturity exists that result in a person to be advocated or delayed as a whole. Skeletal maturity, perhaps the most commonly used index in routine clinical work, is closely related to sexual and somatic maturity. Girls who are skeletally advanced also menstruate early<sup>5</sup>.

#### AIM AND OBJECTIVES

To evaluate relationship between chronological age, dental age and skeletal age by using ossification of middle phalanx of third finger (MP<sub>3</sub>) in Pimpri-Chinchwad boys and girls population. To evaluate the percentage according to age groups of this study in boys & girls at each stage of ossification of middle phalanx of third finger (MP<sub>3</sub>) in Pimpri-Chinchwad boys & girls population. To compare stage of ossification of middle phalanx of third finger (MP<sub>3</sub>) at each age group according to Hagg & Taranger in Pimpri-Chinchwad boys & girls population. To correlate between chronological, dental & skeletal age in Pimpri-Chinchwad boys & girls population.

#### MATERIALS AND METHODS

A questionnaire study was carried in the department of Paediatric and Preventive Dentistry. A total number of 80 children were provided with the questionnaire.

This questionnaire was used for further evaluation in the study as a data source. Age group from 8-15 years both males and females were included in this study. 80 children were included in this study. Inclusion were Boys and girls of this study were domicile of Pimpri-Chinchwad area. Physically and mentally healthy children with no past history of chronic severe illness were included in this study. Children selected in this study were not having history of trauma or injury to the right hand. There was no previous history of any orthodontic treatment in the children selected for this study. There was no history of extraction in the children selected for this study. Exclusions were Un-cooperative children were excluded from this study. Children consuming hormonal or anti-hormonal medicine were not included in this study. Children having oral and congenital deformities were excluded. Children having juvenile diabetes were not included in this study. Children having deformities with their phalanx were excluded from the study. Children whose parents were not willing to carry the study on their child. Three types of study procedures were carried out in the study namely: Chronological age study, Dental age study and Skeletal age study. Chronological age was evaluated by filling up the questionnaire forms by asking certain questions directly to the children / parents. Dental age was evaluated by checking the dental emergence stages (DES) or erupting at that specific age group. 4 age groups were chosen 8-9, 10-11, 12-13 and 14-15. All children were divided into different into age groups according to the age. The children whose age was between 8.1 – 8.9 years were considered in the 8 years group, 9.1-9.9 years in the 9 years age group and so on. Dental age was evaluated by oral examination using mouth mirror and probe. Oral examination was done because it is the most inexpensive way of assessing eruption of teeth, less time consuming, easy way of estimating dental age and without any exposure to x-ray radiations. Skeletal age was evaluated by using middle phalanx of 3<sup>rd</sup> finger MP<sub>3</sub> stages as per given by Hagg and Taranger. Adult IOPA was chosen and middle phalanx of third finger of right hand was placed on the IOPA and then IOPA was taken to check the ossification of bones namely epiphyses and diaphysis. The intra-oral periapical films were processed further & after development & drying, they were traced for checking the ossification of bones of middle phalanx of third finger of right hand by using 50µ thick lead acetate tracing paper (Garware Co.) which has two sides, 1 side matt & other side glossy by using 2H hard pencil (Apsara Co). The traced paper then matched with the template of ossification of bones of middle phalanx of third finger of right hand used by Hagg & Taranger & accordingly identified for stages used by Hagg & Taranger as mentioned above to assess skeletal age of the subject.

## RESULTS

The data was coded and entered in Microsoft Excel Sheet and analyzed using SPSS 10.0 (Statistical Package for Social Sciences, IBM, USA). Comparison of the study participants on the basis of stage of ossification of middle phalanx of third finger (MP<sub>3</sub>) was done using Mann Whitney U test. The correlation of the various methods of age determination was done using Kendall Tau correlation coefficient. P value < 0.05 was considered statistically significant. The study consisted of a total number of 80 participants of whom 43 (53.75%) were males and 37 (46.25%) were females. (Table 1)

**Table 1: DISTRIBUTION OF THE STUDY POPULATION BASED ON GENDER**

Gender	Frequency	Percentage
Males	43	53.75
Females	37	46.25
Total	80	100

The mean of the study participants was  $11.34 \pm 2.43$  years. (Table 2).

**Table 2: DISTRIBUTION OF THE STUDY POPULATION BY AGE**

Gender	Mean Age (in years)	Standard Deviation (in years)
Male	11.34	2.44
Female	11.51	2.45
Total	11.43	2.43

Table 3 shows the distribution and comparison of the study participants on the basis of stage of ossification of middle phalanx of third finger (MP<sub>3</sub>). Among males 9.3 % (n= 4) were at the F Stage, 18.6 % (n=8) at FG stage, 23.3 % (n=10) at G stage, 25.6 % (n=11) at H stage and 23.3 % (n=10) were at I stage of ossification of middle phalanx of third finger (MP<sub>3</sub>). Among females 16.2% (n=6) were at F stage, 5.4% (n=2) at FG stage, 29.7% (n=11) at G stage, 21.6 % (n=8) at H stage and 27.0% (n=10) were at I stage of ossification of middle phalanx of third finger (MP<sub>3</sub>). There was no statistically significant difference at each group according to Hagg and Taranger in between the males and females using Mann Whitney U test (p value = 0.847).

**Table 3: DISTRIBUTION AND COMPARISON OF THE STUDY PARTICIPANTS ON THE BASIS OF STAGE OF OSSIFICATION OF MIDDLE PHALANX THIRD FINGER (MP3)**

Stage of ossification of middle phalanx third finger (MP3)	Males		Females	
	Frequency	Percentage	Frequency	Percentage
F	4	9.3	6	16.2
FG	8	18.6	2	5.4
G	10	23.3	11	29.7
H	11	25.6	8	21.6
I	10	23.3	10	27.0
<b>Mann Whitney U test</b>	776.00			
<b>P value</b>	0.847 (Not Significant)			

Table 4 shows comparison of the study participants on the basis of dental age. The analysis shows that the difference in the dental age among males and females was not statistically significant. (p value = 0.386) The pubertal growth spurt was seen at the mean age of 14.5 years which corresponded to the I stage of ossification of middle phalanx of third finger (MP<sub>3</sub>) in males. Whereas, in females the pubertal growth spurt was at a mean age of 13.5 years. The correlation of the various methods of age determination was done using Kendall Tau correlation coefficient. There was nearly perfect positive correlation between dental age and chronological age in males and females. The correlation coefficient values were 0.934 and 0.932 in males and females respectively.

**Table 4: COMPARISON OF THE STUDY PARTICIPANTS ON THE BASIS OF DENTAL AGE**

Gender	Mann Whitney U Test	P value
Males	5.000	0.386 (Not significant)
Females		

(Table 5) This correlation was found to be statistically highly significant. The correlation of the various methods of age determination was done using Kendall Tau correlation coefficient. There was nearly perfect positive correlation between dental age and skeletal age in males and females. The correlation coefficient values were 0.964 and 0.988 in males and females respectively.

**Table 5: CORRELATION OF DENTAL AGE AND CHRONOLOGICAL AGE IN MALES AND FEMALES**

Gender	Kendall- tau	P value
Males	0.934	0.000 (Highly significant)
Females	0.932	0.000 (Highly significant)

(Table 6). This correlation was found to be statistically highly significant. The correlation of the various methods of age determination was done using Kendall Tau correlation coefficient. There was nearly perfect positive correlation between chronological age and skeletal age in males and females. The correlation coefficient values were 0.903 and 0.918 in males and females respectively.

**Table 6: CORRELATION OF DENTAL AGE AND SKELETAL AGE IN MALES AND FEMALES**

Gender	Kendall- tau	P value
Males	0.964	0.000 (Highly significant)
Females	0.988	0.000 (Highly significant)

(Table 7) This correlation was found to be statistically highly significant.

**Table 7: CORRELATION OF SKELETAL AGE AND CHRONOLOGICAL AGE IN MALES AND FEMALES**

Gender	Kendall- tau	P value
Males	0.903	0.000 (Highly significant)
Females	0.918	0.000 (Highly significant)

## DISCUSSION

Dental age was evaluated by checking the dental emergence stages or eruption at that specific age group. 4 age groups were chosen:- Group I ( 8-9 ), Group II ( 10-11 ), Group III ( 12-13 ) Group IV ( 14-15 ). Dental age was evaluated by oral examination using mouth mirror and probe. This method of oral examination to observe dental emergence stages was carried out because, it is the most inexpensive and easy way of assessing eruption of teeth. It is also less time consuming and doesn't involved exposure to x-ray radiations. Dental age estimation is based upon the rate of development and calcification of tooth buds and the progressive sequence of their eruption in the oral cavity. Several methods have been developed to assess the dental age according to the degree of calcification observed in permanent teeth. In this study, the data for dental age study was recorded by oral examination of maxillary and mandibular dentition, using intra oral mirror. Dental stage was evaluated by Dental Emergence Stages (DES) by checking the eruption of teeth. DES I – (8-9 years),

DES II – (10-11 years), DES III – (12-13 years), DES IV – (14-15 years). The hand-wrist radiograph is commonly used for skeletal development assessment<sup>6</sup>. Also, changes in the epiphysis of middle phalanx of the third finger (MP<sub>3</sub>) follow an orderly sequence. Hagg and Taranger studied pubertal growth from the stages of ossification of the middle phalanx of the hand (MP<sub>3</sub> stages)<sup>1</sup>. Gulati, A et al (1990)<sup>2</sup> stated that malnutrition can have an adverse effect on the dental and skeletal maturity. Salzman, J.A. (1966)<sup>7</sup> and Braham, R. (1980)<sup>8</sup> stated that malnutrition led to general delay in ossification of carpal bones. Stones, H.H. (1966) and Salzman, J.A (1966)<sup>7</sup> found a significant positive association between poor nutrition status and delayed tooth eruption. To minimize these effects, healthy children from Pimpri-Chinchwad population were selected without any physical disability. In the present study skeletal age was determined from the radiographs of MP<sub>3</sub> according to the standards given by Hagg and Taranger<sup>1</sup>. This methods for evaluation of skeletal maturity is dependent upon the appearance, size and different of

various ossification centers and the degrees of fusion between the epiphyses and diaphysis. According to Greulich and Pyle (1950)<sup>9</sup> the epiphyses of the middle phalanx of third finger have been used to illustrate the successive maturity indicators, which are similar for all four finger. MP<sub>3</sub> (middle phalanx of third finger) stages have been used as a part of hand-wrist x-ray to maturity assess skeletal<sup>1</sup>. In this study the co-relation of dental age and chronological age in males and females showed that there was nearly perfect positive correlation between dental age and chronological age in males and females. This correlation was found to be statistically highly significant. In this study, the results showed that females were ahead in skeletal maturation than males. The skeletal age of males and females were evaluated from radiographs of middle phalanx of third finger (MP<sub>3</sub>). On comparison, females were ahead in skeletal maturation than males. This is supported by Magnusson. T.E. (1979)<sup>10</sup> who found that girls reached all stages of skeletal maturity significantly sooner than boys. Hagg, V. and Taranger, J (1982)<sup>1</sup> stated that all growth events and skeletal ages occurred earlier in girls than in boys. Koshy, S. and Tandon. S. (1998)<sup>6</sup> showed that Indian females had a higher skeletal age indicating an early maturation. Similar type of finding regarding maturational parameters have been reported earlier by Hunter, C.J. (1966)<sup>11</sup> Fishman, L.S. (1982)<sup>12</sup> and Sharma, V.P. et al (2002)<sup>13</sup>. Rajagopal, R. and Kansal, S. (2002)<sup>14</sup> have shown that recording MP<sub>3</sub> stages using periapical x-ray film can be an accurate, simple practical and economical growth indicator. This study supports the finding of the above author. Comparison of the study participants were made on the basis of dental age. The analysis shows that the difference in the dental age among males and females was not statistically significant. This was supported by Nolla, C.M (1960)<sup>15</sup>, that there is a significant difference in the rate of dental development in males and females. Bala, M. (2010)<sup>39</sup> found that there is insignificant difference in dental development in males and females. In present study, the correlation between dental age and skeletal age in males and females showed nearly perfect positive correlation between dental age and skeletal in males and females. This finding is in agreement with Sharma, V.P. et al (2005)<sup>36</sup> who found that maxillary canine maturation is closely associated with MP<sub>3</sub> and CVMI stages in the age groups of 12-16 years. Hagg, V and Taranger, J. (1989)<sup>1</sup> noted that the stages of ossification of middle phalanx of the third finger (MP<sub>3</sub>) follow the pubertal growth spurt. Bjork, A. (1976)<sup>16</sup> found that capping of the epiphyses of the third middle phalanx was very closely related to the age of pubertal maximum growth velocity. According to Bala, M. (2010)<sup>17</sup> there is an inconsistent relationship which was observed with dental age and chronological age. Also, for both sexes, skeletal age (from MP<sub>3</sub>) and dental age do not show high correlation with chronological age in all the age groups.

In the present study, there is positive correlation between dental, chronological and skeletal age in all the age groups. This, result is dissimilar to the study of Bala, M. (2010)<sup>17</sup>. This difference could be due to the Small sample size of our study. Ethnic variation of samples used in both the studies. The method of evaluation of dental age used in the study of Bala<sup>17</sup> was different as compared to our study. Rajagopal and Kansal (2002)<sup>14</sup> Sharma et al (2002)<sup>13</sup> showed high correlation of MP<sub>3</sub> and CVMI stages. Thus MP<sub>3</sub> can substitute hand-wrist radiographs for skeletal maturity evaluation. MP<sub>3</sub> radiographs by IOPA x-ray film. The technique has the advantage of being simple, using low patient radiation dose and exhibiting high degree of clarity of the radiographs. The equipment required is available in almost all the dental clinic. In the present study, pubertal growth spurt was seen at the mean age of 14.5 years in males and this corresponds to the I stage of ossification of middle phalanx third finger (MP<sub>3</sub>). Whereas in females the pubertal growth spurt corresponded to the H and I stages of ossification of middle phalanx third finger (MP<sub>3</sub>) which were at a mean age of 13.5 years and 14.6 years respectively. This was supported by Hagg, V. and Taranger, J. (1980)<sup>1</sup> and Abdel-Kader, H.M. (1998)<sup>18</sup>.

## CONCLUSION

In females skeletal maturity was ahead of males. There was no significant difference in dental age among males and females. Difference in chronological age among males and females was not statistically significant. The pubertal growth spurt in males of Pimpri-Chinchwad population selected for this study was seen at the mean age of 14.5 years which corresponded to I stages of ossification of middle phalanx third finger (MP<sub>3</sub>). In females the pubertal growth spurt corresponded to H & I stages of ossification of middle phalanx third finger (MP<sub>3</sub>) which was at a mean age of 13.5 years. The correlation between chronological age, dental age and skeletal age was significant according to the result. Thus, chronological age can be used to estimate dental age, dental age can be used to estimate skeletal age and skeletal age can be used to estimate chronological age in children from Pimpri-Chinchwad population.

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