Comparison of Middle Phalynx of Third Finger and Lower Mandibular Canine Calcification As A Skeletal Maturity Indicator In 9 To 15 Years

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Abstract

Aim: The aim of this study is to evaluate the relationship between lower canine calcification stages and Middle Phalynx of Third Finger (MP3) ossification stages and the prospects for the mandibular canine tooth to be used as a pubertal growth spurt indicator.

Materials and Methods: The sample for the study was derived from subjects registered as patients at Thai Moogambigai dental college and hospital, Chennai. The sample includes 60 Subjects, 30 boys and 30 girls. The age group of 9 to 15years was chosen as the growth spurt events occur during this period.

Results: The MP3 stages and lower canine calcification stages for boys and for girls showed significant results showing p value is 0.001 for the genders indicating a significant association between the two assessments. Chi-square statistic was applied to test the associations between skeletal and dental stages.

Conclusion: The stages of root formation of mandibular canine coincided with onset of pubertal growth spurt of the stage MP3-H and canine H stages and MP3-F and canine F stages in both boys and girls and, the boys showed an association with MP3-FG and Canine

G stage suggesting that these stages can be used for assessing the pubertal growth status.

Keywords: Growth prediction, skeletal maturity indicators, dental age.

Introduction

In the orthodontic treatment planning, knowledge of growth velocity and percentage of growth remaining is very important for effective growth modification interventions. It is based on each patient skeletal maturation and dental maturation.

The timing of growth varies because each has his or her own biological clock. This transformation is crucial for orthodontics as an aid in the diagnostic, planning and early treatment of anomalies, since the success or failure of orthodontic treatment is interlinked with craniofacial growth and development 1. The success of treating a growing patient lies in harnessing the growth at the right age. However chronological age is often inadequate for assessing the developmental status.

Conventionally hand-wrist radiographs or lateral cephalograms have been used to assess skeletal maturity level. However, this facility is not available at the chair side and involves more cost, time and visits for the patient. The routine use of hand-wrist radiographs has also been lately questioned from the radiation-hygiene and safety point of view. If a strong association exists between the skeletal maturity status and permanent lower canine calcification stages, the stages of calcification of permanent lower canine tooth might itself be used as a first-level diagnostic tool to estimate the skeletal maturity status and the growth potential of the patient 1.

This study is aimed to use Orthopanoramic radiographs instead of hand wrist radiograph predicting growth potential among growing individuals.

Materials And Methods

The sample of 60 Subjects, 30 boys and 30 girls subjects registered as patients at Thai Moogambigai dental college and hospital, Chennai with the age group of 9 to 15years and they were explained the need and design of the study and a written consent was obtained.

The subjects were divided into six groups according to their chronological ages and ten patients were taken into each group. They are

Group 1: includes ten subjects with age ranges from 9 years to 10 years.

Group 2: includes ten subjects with age ranges from 10 years to 11 years.

Group 3: includes ten subjects with age ranges from 11 years to 12 years.

Group 4: includes ten subjects with age ranges from 12 years to 13 years.

Group 5: includes ten subjects with age ranges from 13 years to 14 years.

Group 6: includes ten subjects with age ranges from 14 years to 15 years. Exclusion criteria.

The subjects who had previous history of trauma or injury to the face or the hand wrist regions and those who were wearing any intraoral appliance , who are having congenital anomalies and any serious illness were excluded from the study.

Method: MP3 ossification stages- Hagg and Taranger method

MP3- F stage: Start of the curve of pubertal growth spurt

1. Epiphysis is as wide as metaphysic.

2. Ends of epiphysis are tapered and rounded.

3. Metaphysic shows no undulation.

4. Radiolucent gap (representing cartilaginous epiphyseal growth plate) between epiphysis and metaphysic is wide.

Mp3 - F G Stage: Acceleration of the curve of pubertal growth spurt

1. Epiphysis is as wide as metaphysic.

2. Distinct medial and/or lateral border of epiphysis forms line of demarcation at right angle to distal border.

3. Metaphysis begins to show slight undulation.

4. Radiolucent gap between metaphysic and epiphysis is wide.

Mp3- G stage: Maximum point of pubertal growth spurt

1. Sides of epiphysis have thickened and cap its metaphysic, forming sharp distal on one or both sides 2. A marked undulation in metaphysic gives it "cupid's bow" appearance. 3. Radiolucent gap between epiphysis and metaphysic is moderate.

**MP3 - H stage:** Deceleration of the curve of pubertal growth spurt

1. Fusion of epiphysis and metaphysic begins.

2. One or both sides of epiphysis form obtuse angle to distal border.

3. Epiphysis is beginning to narrow.

4. Slight convexity is seen under central part of metaphysic.

5. Typical "cupid's bow" appearance of metaphysic is absent, but slight undulation is distinctly present.

6. Radio lucent gap between epiphysis and metaphysic is narrower.

Results

The measurement of agreement for the MP3 stages and lower canine calcification stages between the first and second assessment is shown in Table 1. The P value for canine and MP3 stages for boys and for girls 0.001 .The P value is (0.001) for all parameters in both the genders indicating a significant association between the two assessments
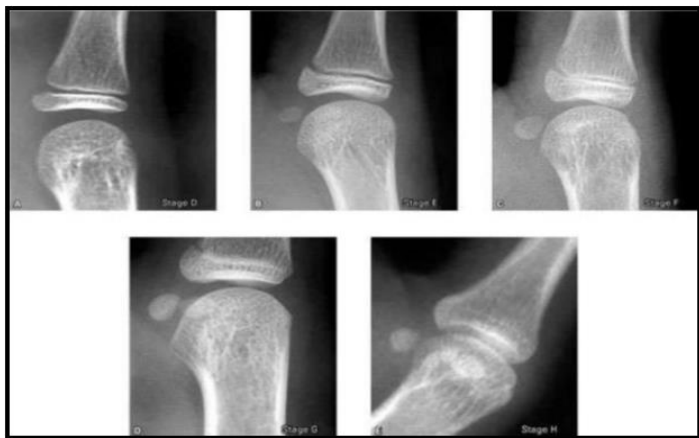
Boys

Mp3-F Stage

At the MP3-F stage , the canine stage F showed the highest percent distribution of 85%.There is only 15% correlation with G stage and no canine H stages seen, Indicating a strong association between MP3-F and canine F stages.

Mp3 Fg Stage

At the MP3-FG stage, the canine stage G showed 15% distribution and canine stage F showed 54% distribution indicating an association between MP3-FG stage and the Canine stage G.

Mp3-G Stage

At the MP3-G stage, the canine stage G showed 23% distribution while canine stages F and H showed 50% distribution.

Mp3- H Stage

At The MP3-H Stage, The Canine Stage H Showed A 25% Distribution Indicating A Strong Association. The Canine Stage G Showed 8% Distribution And Showed No Canine F Stages Indicating A Strong Association Between MP3 H Stage And Canine Stage H.

Girls:

Mp3 F Stage

At the MP3-F stage, the canine stage F showed 50% distribution and the canine stage G showed 10% distribution indicating an association between MP3-F and canine F stages.

Mp3 Fg Stage

At the MP3 FG stage, the canine stage F showed 40 % distribution and canine stage G showed 31% distribution indicating no strong associations.

Mp3 - G Stage

At the MP3-G stage, the canine stage showed 43% distribution while canine stages F and H showed 10% and 17% distribution respectively indicating only a mild association between the MP3-G stage and the canine stage G.

MP3 - H Stage At the MP3-H stage, the canine stage H showed a 50% distribution of ,canine stages . G stage showed 29% indicating an association between canine H stage and MP3H stage.

Mp3 I Stage At the MP3-I stage, the canine stage H showed a 33% distribution canine stages F and G showed no correlations Thus, statistically significant association is present between MP3-H and canine H stages and MP3-F and canine F stages in both boys and girls and, the boys showed an association with MP3-FG and Canine G stage.

TABLE-1 TOTAL SUBJECTS IN MP3 AND CANINE STAGES

MP3 Stages	Total subject in MP3 Stages	Canine stages			P-Value
		CF	CG	CH	
F	19	16	3	0	0.001
FG	17	6	10	1	0.001
G	13	1	9	3	0.001
H	9	0	5	4	0.001
I	2	0	0	2	0.001
Total	60	23	27	10	

TABLE-2 ASSOCIATION OF MP3 AND CANINE CALCIFICATION STAGES IN MALES

MP3 Stages	Total subject in MP3 Stages	Canine stages			P-Value
		CF	CG	CH	
F	13	11	2	0	0.01
FG	10	2	7	1	0.01
G	5	0	3	2	0.01
H	2	0	1	1	0.01
I	0	0	0	0	0.01
Total	30	13	13	4	

TABLE-3 ASSOCIATION OF MP3 AND CANINE CALCIFICATION STAGES IN FEMALES

MP3 Stages	Total subject in MP3 Stages	Canine stages			P-Value
		CF	CG	CH	
F	6	5	1	0	0.01
FG	7	4	3	0	0.01
G	8	1	6	1	0.01
H	7	0	4	3	0.01
I	2	0	0	2	0.01
Total	30	10	14	6	
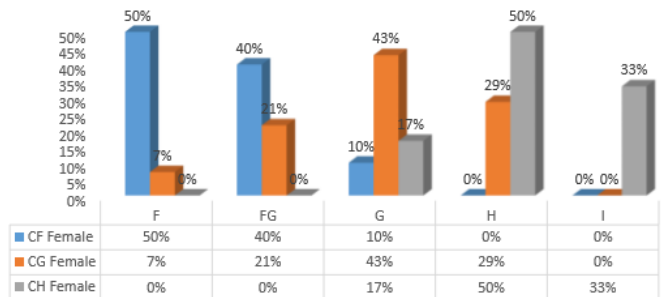
TABLE-4-PERCENTAGAE DISTRIBUTION OF THE MP3 STAGES AND CANINE CLASSIFICATION STAGES

MP3 Stages	CF		CG		CH	
	Male	Female	Male	Female	Male	Female
F	85%	50%	15%	7%	0%	0%
FG	15%	40%	54%	21%	25%	0%
G	0%	10%	23%	43%	50%	17%
H	0%	0%	8%	29%	25%	50%
I	0%	0%	0%	0%	0%	33%
Total	100%	100%	100%	100%	100%	100%

TABLE-5 MEAN VALUE OF CHRONOLOGICAL AGE IN YEARS FOR MP3 STAGES IN MALE AND FEMALE

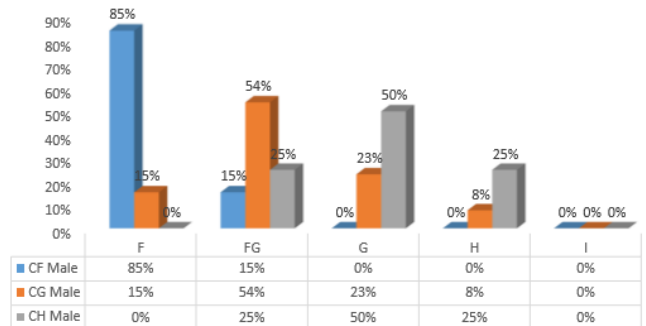| MP3 Stages	MALE (Mean ± STD)	FEMALE (Mean ± STD)	Mean Difference
F	11.61±1.94	11.25±2.25	**0.4**
FG	11.6±1.58	11.66±1.99	**0.1**
G	12.4±2.41	12.12±2.03	**0.3**
H	12.5±3.54	12±2.16	**0.5**
I	-	14.5±0.71	**0.0**

TABLE-6 MEAN VALUE OF CHRONOLOGICAL AGE IN YEARS FOR CANINE STAGES IN MALE AND FEMALE

Canine stages	MALE (Mean ± STD)	FEMALE (Mean ± STD)	Mean Difference Male
F	11.3±1.9	11.4±2.0	**-0.1**
G	11.6±1.5	12±1.7	**-0.4**
H	13.7±1.6	12.6±2.2	**1.1**

Percentage Distribution of the MP3 and canine calcificationn stages in male

	F	FG	G	H	I
CF Male	85%	15%	0%	0%	0%
CG Male	15%	54%	23%	8%	0%
CH Male	0%	25%	50%	25%	0%

Percentage Distribution of the MP3 and canine calcification stages in female

	F	FG	G	H	I
CF Female	50%	40%	10%	0%	0%
CG Female	7%	21%	43%	29%	0%
CH Female	0%	0%	17%	50%	33%

Discussion

Coutinho, Buschang, Miranda in 1993[2]assessed the hand-wrist radiographs and dental panoramic radiographs of 200 boys and 215 girls to determine the relationship between the development stages of the mandibular canine and

skeletal maturity indicators of the pubertal growth spurt. Skeletal age was determined from hand-wrist radiographs according to methods described by Greulich and pyle. The phalangeal maturity stages and the appearance of the adductor sesamoid were defined by using the Tanner and Whitehouse method. The development of the mandibular canine was assessed according to Demirjian's stages of Dental calcification. It was concluded that a close association exists between mandibular canine calcification stage and skeletal the highest relationship with canine maturity for both sexes, followed by the fifth proximal phalanx and the third distal phalanx.

Krailassi S, Niwat A, Surachai D, in 2002[3] investigated the relationship between stages of calcification of various teeth and skeletal maturity among Thai individuals. The study subjects consisted of 139 male and 222 female subjects ranging in age from 7-19 years. A total of 361 hand wrist and panoramic radiographs were obtained and analyzed. The tooth development of the mandibular canines, first and second premolars and second and third molars were assessed according to Demirjians system. Skeletal age and skeletal maturity stages were determined from hand-wrist radiographs using the method outlined in the atlas of Gruelich and Pyle and Fishman system respectively. The study showed that tooth calcification stages from panoramic radiographs might be clinically useful as a maturity indicator of pubertal growth period. They also recommend future studies addressing development of canines and second molars in a larger sample size

Madhu S, Amita M and Munshi A.K. in 2003[4]studied the MP3 radiographs to provide a simple and practical method of skeletal maturity assessment using the development stages of the middle phalynx of the third finger as seen on IOPA film taken using a standard X-ray machine. The MP3 stages were compared with the CVMI stages. The result of the study indicated that this simple method was highly reliable and could be used as alternative method to assess skeletal maturity of growing children.

R Divyashree et al 2010[5] conducted a study to investigate the association of mandibular canine calcification to MP3 ossification stages and its potential to be used as pubertal growth spurt indicator in Chennai population and compared the difference in the timing of these events in boys and girls based on their chronological age to study any sexual dimorphism. The results of the study showed the stages of root formation of mandibular canine indicated only the onset of pubertal growth spurt for both the sexes

Mithul Joshi, Dinesh Rao, Shubha Ab, Sunil Panwar And Sachin Franklin 2018[6]to assess the correlation between the calcification stage of mandibular second molar and the modified middle phalanx of third finger (modified MP3) of 9 to 16 years of old children . A strong association was found between calcification stages of the modified middle phalanx of third finger of right hand in both the gender . there was a concordance between the stages of modified middle phalanx of third finger and the demirjian's tooth developmental stages.

In clinical orthodontics, determination of the maturational status of the patient and subsequent evaluation of the growth potential is extremely important. Growth, particularly during puberty, is of value in the treatment of skeletal problems.[7]The next logical question is how to determine whether an adolescent patient is going to grow.

The chronological age is not a reliable indicator of skeletal maturation. The biologic or physiologic age as assessed by annual growth increments in height or weight or secondary sexual characteristics are the easiest and usually the most available measurements but are of limited value for immediate clinical judgment. [8] The most accurate has been the skeletal age to determine the growth of a patient.

The hand-wrist radiographs are commonly used for skeletal developmental assessment. A number of methods

have been described in the literature to assess the skeletal age using hand-wrist radiographs. In the current age of radiation awareness and concern, a need arises to carefully determine and justify the amount of radiological exposures. With this thought in mind many authors have attempted successfully to simplify the existing maturity indicators. Hagg and Taranger[9] in their study used a series of discrete stages of changes in the middle phalanx of the third finger of the hand (MP3) to determine the entire process of pubertal growth spurt 9,10 from onset to completion. The stages of ossification of MP3 were shown to follow the pubertal growth spurt. Use of periodical or digital radiographs for ossification centers in different fingers also has been found to be as reliable as other complex methods of skeletal maturation assessment. Ready access to in-office intraoral

radiographic imaging devices and reduced radiation exposure with digital imaging represent distinct advantages. Hence hand wrist radiographs were take.11,12,4

Correlation between calcification stages of individual teeth and skeletal maturity have also been previously reported. Demisch and Wartman[13] report a high correlation between dental and skeletal ages, Chertkow[14], Coutinho[15] et al, Krailassiriet al[3], and Engstrorm[16] et al report similar high correlations. On the other hand, Lewis and Garn[17], and Tanner [18] have reported low or insignificant correlations between the level of skeletal and dental maturation. The lack of concordance among the results of previous studies may be attributed, at least in part, to the different methods used for assessing skeletal and dental maturity.

Relationships between the stages of tooth mineralization of the mandibular canine appear to correlate better with ossification stages than the other teeth.19 So the stages of calcification of canine have been used to assess the

pubertal growth status of the patient. Chertkow[14] and Fatti[20], Sierra[21], and Continuo et al[15] have suggested a high relationship between calcification of mandibular canine and skeletal maturity indicators.

The calcification stages of mandibular canine tooth were assessed using the method described by Demirjian et al[22]. This method is based on distinct details of shape and proportion of root length, using the relative value of crown height, rather than the absolute length. Foreshortened or elongated projections of developing teeth do not affect the reliability of assessment. Therefore, the use of this method in this study helped in minimizing observational errors.23

Panoramic radiographs are taken to assess the mandibular canine calcification stages as it is usually taken before starting an orthodontic treatment and thereby the need for an additional radiation exposure to take another radiograph can be avoided.

Krailassiri et al[3] and Coutinho et al [15] reported that the associations between the tooth calcification stages and the skeletal maturity indicators probably allow the clinician to more easily indentify the stages of the pubertal growth period from the panoramic radiograph. Digital panoramic radiographs are used which will further reduce the amount of radiation exposure.

Tooth mineralization relative to stages of skeletal maturation is considered separately for male and female subjects in this study. The findings of Krailassiri et al[3] indicated that maturation patterns of tooth development in male subjects tend to be more as compared with female subjects in relation to skeletal maturity stages. Chertkow 24 reported that a markedly more advanced trend in tooth calcification was evident among the boys in both black and white racial groups. Conversely, Basaran et al 23 stated that boys showed late dental development.

The sample included 60 healthy subjects, 30 boys and 30 girls. The age group of 9 to 15 years was chosen, as the

pubertal growth spurt events occur during this period. The inspection and staging of the Hand wrist and OPG is performed twice without having access to the information regarding patient's identity, chronological age or sex or to the initial set. The readings are decoded and tabulated and statistically analyzed.

Conclusion

The Following conclusions were obtained:

The P value for canine and MP3 stages for boys and girls 0.001. The P value is (0.001) for all the parameters in both the genders indicating a significant association between the two assessments.

Statically significant association is present between MP3-H and canine H stages and MP3-F and canine F stages in both boys and girls and, the boys showed an association with MP3-FG and Canine G stage suggesting that these stages can be used for assessing the pubertal growth status. The stages of root formation of mandibular canine coincided with onset of pubertal growth spurt and also the period of decelerating growth velocity for both the sexes. So it can be used for assessing these two periods. However the relationship was not consistent for the other stages of skeletal maturation and differed between boys and girls. So the canine calcification stages cannot be used to indicate the acceleration phase and peak growth period.

Further studies with more samples are need to evaluate the potential for mandibular canine tooth to be used as a pubertal growth spurt indicator.

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