ORIGINAL RESEARCH PAPER

Volume-8 | Issue-4 | April-2019 | PRINT ISSN No 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

AN EVALUATION OF SKELETAL AGE USING LATERAL CEPHALOGRAM FOR CERVICAL VERTEBRAE AND INTRAORAL PERIAPICAL X-RAY FOR MP3 : A RADIOGRAPHIC STUDY

Orthodontics

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ABSTRACT

Objectives: To evaluate skeletal age using lateral cephalogram for cervical vertebrae and intraoral periapical X-ray for MP3 among Kanpur individuals and to correlate the age assessed by stages of ossification of Middle Phalanx of third finger (in IOPAR) with the age assessed by cervical vertebral maturation indicators..

Materials and Methods: A radiographic study consisted of a total 90 subjects 45 boys age from 10-13 years and 45 girls age from 9-12 years which was further divided into subgroups A1, B1, C1 and A2, B2, C2 respectively with 15 subjects in each subgroup. The study included digital radiographs of the MP3 of the right hand and conventional lateral cephalograms. Chronological age was assessed by the date of birth, MP3 maturation by Rajagopal and Kansal's criteria, and CVMI development by Lamparski method.

Statistical Analysis: Spearman's rank-order correlation coefficient was applied to assess the correlation between stages of MP3 and CVMI.

Results: Progressive stages of MP3 and CVMI were seen as chronological age advanced. The correlation between MP3 and Cervical Vertebral Maturation method was found to be highly significant for both males and females. Skeletal maturation occurs at an earlier chronological age in females than in males. Chronological age is not a reliable indicator for skeletal age. . MP3 and CVMI stages showed a strong positive correlation rs=0.8723 ($p<0.0001$)**.

Conclusions: It is feasible to record MP3 stages with standard periapical X-ray film as it can be used as simple, practical and economical method for making decisions on treatment timing.

KEYWORDS

INTRODUCTION

Growth is a biological and histological combination of morphogenetic and histogenetic variations occurring in reaction to genetic coding and environmental influences over a period of time.[1] Human Growth is symbolized by variations in the rate of progress of different individuals toward physiologic maturity. Assessment of developmental status is determined in respect to the events which takes place during the progress of growth. Assessment of maturation status of an individual is compelling before planning orthodontic treatment and becomes even more significant, when the treatment requires orthopaedic correction.

The growth indicators such as chronological age, dental development, height and weight, secondary sexual characteristics and skeletal age are used for assessment of developmental status of an individual.[2] Assessing maturational status, whether the pubertal growth spurt of that patient has been reached or completed, can have a considerable significance on diagnosis, treatment goals, treatment planning, and the inevitable outcome of orthodontic treatment.[3,4] Assessment of maturational status aids in cases of syndrome identification and forensic science and also aids in cases of metabolic diseases and endocrine disorders.

Accurate estimation of maturation level of an individual is of particular interest to an orthodontist especially as it aids in deciding the mode of treatment.[5] Skeletal maturation is assessed by a cervical vertebral maturation method given by Hassel and Farman, and by Baccetti and Franchi, and middle phalanx of the third finger (MP3) given by Rajagopal and Kansal is also used to assess skeletal maturation. In recent years, determination of the skeletal maturation is done by evaluation of cervical vertebrae in lateral cephalograms. The early version of the cervical vertebral maturation method (CVM) was shown to be a valid tool to predict the peak of pubertal growth. The CVM method, in the early or the improved version, has been used to evaluate the clinical effectiveness at different skeletal maturation stages of the Bionator, RME, Twin Block.[9]

AIMS AND OBJECTIVES

1. To evaluate skeletal age using lateral cephalogram for cervical vertebrae and intraoral periapical X-ray for MP3 among Kanpur individuals.
2. To correlate the age assessed by stages of ossification of Middle Phalanx of third finger (in IOPAR) with the age assessed by cervical vertebral maturation indicators.
3. To find out the possible sex differences between males and females.
4. To derive its validity and applicability in assessing skeletal age of a patient.
5. To derive the useful clinical implication from the result.

MATERIALS AND METHODS

The present study was contemplated to correlate the stages of ossification of middle phalanx of third finger (MP3) and to the cervical vertebral maturation in both boys between age from 10-13 years and girls between age range 9-12 years . The study was also conducted to compare the chronological age with age assessed by Cervical Vertebrae Maturity Indicators and age assessed by ossification stages of Middle Phalanx of third finger.

The study sample consisted of a total of 90 subjects 45 boys and 45 girls which was further divided into subgroups A1, B1, C1 and A2, B2, C2 respectively with 15 subjects in each subgroup.

The sample was selected from the outpatient Department of Orthodontics and Dentofacial orthopedics, Rama Dental College – Hospital And Research Centre, Kanpur in association with the Deprtment of Pedodontics, Preventive Dentistry, Oral Medicine And Radiology. Prior to the commencement of study ethical clearance was obtained from the ethical committee of the institution.

Correlation of the stages of ossification of Middle Phalanx of third finger (MP3) and Cervical Vertebral Maturation

SELECTION CRITERIA

INCLUSION CRITERIA

1. The entire sample had been taken from Kanpur, well nourished, and free of any known serious illness.
2. The subjects were in the age range of 9-13 years.
3. All the subjects selected were moderately built and were of growing age with no history of deformities, bone diseases and major illness in the past.
4. None of the subjects showed any facial asymmetry.
5. No history of trauma or surgery in the dentofacial region.
6. The MP3 and cephalometric radiographs were available with high clarity and good contrast.

EXCLUSION CRITERIA

1. Malocclusion associated with muscular dystrophy, congenital abnormalities affecting growth and development, traumatic lesions of cervical vertebrae, jaws were excluded.
2. Malocclusion associated with craniofacial syndromes.
3. Prior orthodontic therapy.

All the subjects were divided in to two groups: Group 1 consisted of 45 males (age ranges 10-13 years) and Group 2 consisted of 45 females (age ranges 9-12 years). The present study was based on lateral cephalometric radiographs, Middle Phalanx Of third finger radiographs of 90 samples. Each group was further divided into three subgroups on the basis of age Group 1 was subdivided into A_1, B_1, C_1 and Group 2 was subdivided into A_2, B_2, C_2.

The nature of study was explained to the patients and were briefed about the method of collection of sample (Radiographic) and their consent was taken prior to the commencement of study.

METHODS OF COLLECTION OF DATA

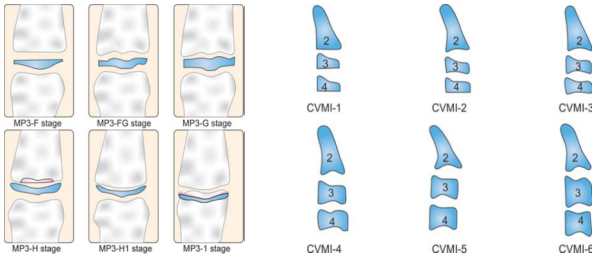
Standardized lateral cephalometric radiograph of each individual was taken with a Villa cephalostat the universal counter balancing type of cephalostat at Rama Dental College Kanpur Uttar Pradesh.

Kodak' X-ray films (8 × 10) were exposed to 70 KVp, 45 mA for an average of 1.8 sec, with a tube to film distance of 6 feet. All the usual protective measures for radiographic exposure were followed in each patient.

Periapical radiograph for recording the stages of MP3 was taken by instructing the individual to place the right hand with the palm downward on a flat table, then middle finger was centered on a 31 × 41 mm periapical dental X-ray film, parallel with the long axis of the film. The cone of the dental X-ray machine was positioned in slight contact with the middle phalanx, perpendicular to the film. The film was exposed to 70 kV power and 8 mA for an average of 0.4 seconds.

In the present study, radiographic interpretation was made as per the system developed to interpret skeletal maturation given by;

1. Rajagopal R, Kansal S (2002)[10] : on radiographs as skeletal maturity indicator.
2. Lamparski (1995)[11] : on lateral cephalogram, the cervical vertebrae as skeletal maturity indicators (CVMI).



Six modified stages of Mp3 Cervical vertebrae maturity indicators

STATISTICAL ANALYSIS

Data was analysed using STATA-12.0 (STATA SE, StataCorp., Texas, USA). Descriptive statistics included calculation of means and standard deviation. Data distribution was assessed for Normality using Shapiro-Wilk test, and accordingly Student's paired t-test was applied for comparing parametric data and Wilcoxon signrank test was used for comparing non-parametric data.

Correlation was assessed between age assessed by different methods using Spearman's correlation co-efficient. All values were considered statistically significant for a value of $p<0.05$. Results- the study group consisted of 90 subjects, divided into sub-groups according to age group and gender as shown in Table 1. Mean chronological age of the study sample was 10.98 years, with the mean age among boys being 11.48 years and mean age among girls being 10.48 years

RESULT

Table 1: Showing Mean Chronological age of subjects according to gender and age-groups

GROUP I- Males				GROUP II- Females			
Sub group	Age group (years)	Number of subjects (n)	Chronological age in years (Mean±SD)	Sub group	Age group (years)	Number of subjects (n)	Chronological age in years (Mean±SD)
A1	10-11	15	10.48±0.27	A2	9-10	15	9.48±0.31
B1	11-12	15	11.44±0.29	B2	10-11	15	10.48±0.26
C1	12-13	15	12.51±0.26	C2	11-12	15	11.48±0.26
Total		45	11.48±0.88	Total		45	10.48±0.87

Figure 1: Showing mean chronological age of subjects according to gender and age-groups

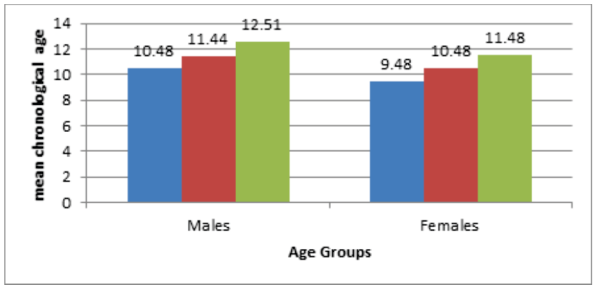


Table 2: showing age (in years) assessed by CVMI according to gender

CVMI-indicator	Mean age (in years) assessed by CVMI					
	No. of subjects (n)	Group I-Males (Mean ± SD)	No. of subjects (n)	Group II-Females (Mean ± SD)	Total No. of subjects (n)	Mean ± SD
CS-1	2	12.3 ± 0.28	0	-	2	12.3 ± 0.28
CS-2	17	10.76 ±02.42	9	9.92±0	26	10.47 ± 1.98
CS-3	23	11.79 ±1.82e-15	18	10.34±0	41	11.15 ± 0.72
CS-4	3	12.06±0	18	10.89±0	21	11.05 ± 0.42

Figure 2: Showing age assessment by CVMI indicator, according to gender

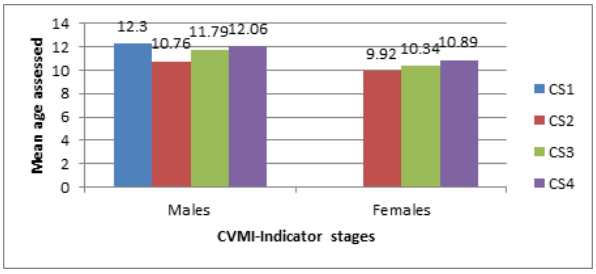


Table 3: showing age (in years) assessed by MP3 according to gender

MP3 indicator	Mean age (in years) assessed by MP3					
	No. of subjects (n)	Group I-Males (Mean±SD)	No. of subjects (n)	Group II-Females (Mean±SD)	Total No. of subjects (n)	Mean ± SD
F	3	11.93±0	1	11.8±0	4	11.89±0.06
G	18	11.62±0	14	9.87±0	32	10.85±0.88
H	4	11.8± 2.18e-15	21	11.0±0	25	11.1±0.27
FG	20	11.21±0	9	10.5±0	29	10.98±0.33

Figure 3: Showing age assessment by MP3 indicator, according to gender

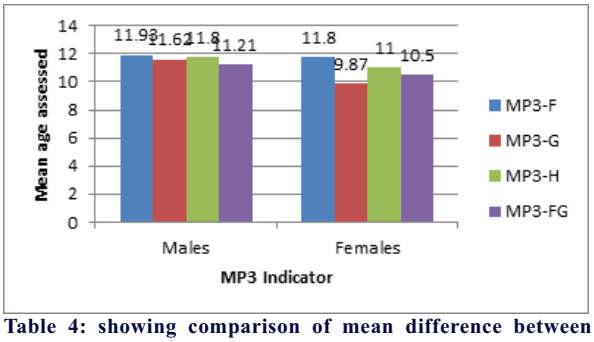


Table 4: showing comparison of mean difference between chronological age with age by CVMI, age by Mp3.

Sub-groups	No. of subjects	Comparison between Chronological age & age by CVMI z-statistic (p-value)a	Comparison between Chronological age & age by MP3 t-statistic (p-value)b
A1	15	-2.55 (p= 0.0106)*	-10.00 (p<0.0001)**
B1	15	-3.24 (p= 0.0012)*	-1.01 (p=0.329)NS
C1	15	3.40 (p=0.0007)**	9.19 (p<0.0001)**
A2	15	-3.41 (p=0.0006)**	-4.68 (p=0.0003)**
B2	15	-0.227 (p=0.820)NS	-0.687 (p=0.502)NS
C2	15	3.410 (p=0.0007)**	5.47 (p=0.0001)**

a- Wilcoxon signrank test; b- Student's paired t-test;
*p<0.05- statistically significant; **p<0.001- highly statistically significant; NS- Not significant.

Table: showing comparison of difference between chronological age and age assessed by CVMI, according to sub groups

Sub-groups	No. of subjects	Difference between Chronological age & age by CVMI Median (min, max)	z-statistic	p-value
A1	15	-0.95 (-1.79, 8.85)	-2.55	0.0106*
B1	15	- 0.25 (-.79, .15)	-3.24	0.0012*
C1	15	.91 (.1, 1.55)	3.40	0.0007**
A2	15	-0.64 (-1.69, -.02)	-3.41	0.0006**
B2	15	.01 (-.69, .56)	-0.227	0.820NS
C2	15	.71 (.21, 1.78)	3.410	p=0.0007**

Wilcoxon signrank test

*p<0.05- statistically significant; **p<0.001- highly statistically significant; NS- Not significant

Table: showing comparison of difference between chronological age and age assessed by MP3, according to sub groups.

Sub-groups	No. of subjects	Difference between Chronological age & age by Mp3 Mean ± SD	t-statistic	p-value
A1	15	-0.88± 0.34	-10.00	<0.0001**
B1	15	-.07± 0.30	-1.01	0.329NS
C1	15	0.97± 0.41	9.19	<0.0001**
A2	15	-0.70± 0.58	-4.68	0.0003**
B2	15	-0.11± 0.61	-0.687	0.502NS
C2	15	0.56± 0.39	5.47	0.0001**

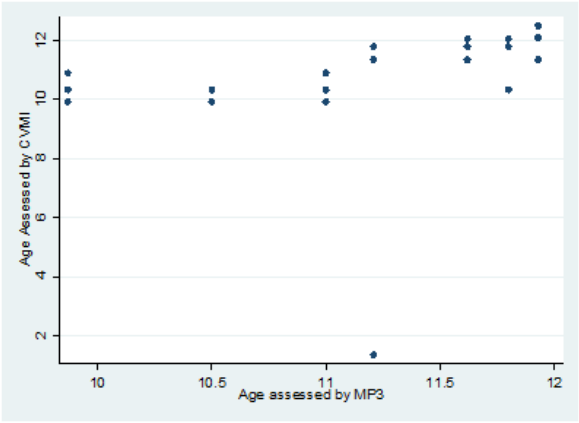
Student's paired t-test
*p<0.05- statistically significant; **p<0.001- highly statistically significant; NS- Not significant

Table 5: showing correlation of age by MP3 with age by CVMI according to gender.

Group	Correlation between age by CVMI and age by MP3
Group I: males (45)	rs=0.6973 (p<0.0001)**
Group II: Females (45)	rs=0.6571 (p<0.0001)**
Total (90)	rs=0.8723 (p<0.0001)**

rs= Spearman's correlation co-efficient
*p<0.05- statistically significant; **p<0.001- highly statistically significant; NS- Not significant

Figure 4: scatter plot showing correlation between age assessed by CVMI and age assessed by Mp3



DISCUSSION

The assessment of skeletal age and pubertal growth spurt in particular are of prime importance in diagnosis, treatment planning and retention after orthodontic treatment. The duration and effectiveness of orthodontic treatment, as well as the permanence of its effects, depend on the timing of the treatment[12,13]. The key issue with any of these growth assessment methods is reliability. The skeletal maturity of the middle phalanx of third finger and the cervical vertebrae, is closely related to growth of the craniofacial region, and skeletal maturity indices are reliable predictors of sexual and somatic maturity as well[14].

The result of this study revealed that the chronological age is not a valid predictor of skeletal growth velocity or skeletal maturity, maturation of middle phalanx of third finger and cervical vertebrae progresses with advancing age[15,16]. In all subgroups, the CVMI and MP3 stages were more advanced in females than in males. At the same chronological age, sexual dimorphism existed both for cervical vertebrae maturation and middle phalanx of third finger, indicating their resemblance[17,18]. This is in concordance with study conducted by Joseph[19], Hunter[20], Fishman.[21]

In this study the age in years was assessed by CVMI-1, CVMI-2, CVMI-3 and CVMI-4 in Group-I Males and Group-II Females. Maximum number of subjects were found in CVMI-3 stage (23) in Group I Males with mean age assessed 11.79 whereas it was found to be 13.2 in the study conducted by Sachan et al[22]. In Group II Females the maximum number of subjects were found in CVMI-3 and CVMI-4 stage (18) with mean age assessed 10.34 and 10.89 respectively whereas it was found to be 11.8 and 12.8 respectively in the study conducted by Sachan et al[22]. Minimum number of subjects were found in CVMI-1 stage (2) with mean age assessed 12.3 in Group I Males whereas it was found to be 11.6 in the study conducted by Sachan et al[22] and no subjects were found in Group II Females whereas the mean age assessed in the study by Sachan et al[22] was 10.4. In all the subjects females attained maturity earlier than males.

The comparison of mean difference between the chronological age & age assessed by Cervical Vertebrae Maturity Indicator was highly significant in C1 males (12-13yr), A2 females (9-10yr) and C2 females (11-12yr), significant in A1 males (10-11yr) and B1 males (11-12yr), and non significant in B2 females (12-13yr). Whereas in the study conducted by Sachan et al[22] the comparison of mean difference was highly significant in A1 males (10-11yr) , B1 males (11-12yr) and A2 females (9-10yr), significant in B2 females (12-13yr), and non significant in C1 males (12-13yr) , C2 females (11-12yr).

The difference between the chronological age & age assessed by Cervical Vertebrae Maturity Indicator was highly significant in the study conducted by Kiran et al. The comparison of mean difference between the Chronological age & age assessed by Middle Phalanx of third finger was highly significant in A1 males (10-11yr), C1 males

(12-13yr), A2 females (9-10yr) and C2 females (11-12yr) whereas it was non-significant in the study conducted by Madhu S[23] and the comparison of mean difference was non-significant in B1 males (11-12yr) and B2 females (12-13yr). In this study the overall correlation coefficient between CVMI with MP3 was found to be r = 0.8723 whereas in the study conducted by Tikku et al[24] and by Bala and Pathak[25], Negi[26] et al.the correlation between CVMI and MP3 was lower r = 0.751 and r = 0.793 respectively. Rajagopal and Kansal[10] in their study showed high correlation of MP3 and CVMI stages.

Statistically a high correlation was also found between MP3 and CVMI stage in the study conducted by Dabla et al [27] which indicates that these methods can be used alternatively to assess skeletal maturity this is also in confirmation with Hag and Taranger (1982), Leite et al[28] (1987), Hassel and Farmen[7] (1995) and Prasad M, Suresh V, Ganji K and Shetty SK[29]. In the present study, there was a significant difference between chronological age and skeletal age assessed by MP3 and CVMI. This supported the fact that skeletal maturation showed variation in comparison to chronological age. Hence, chronological age is not a reliable predictor to assess the maturation status. This is in confirmation with the studies conducted by Hunter[30] which shows a significant difference between the chronological age and skeletal age and the study conducted by Fishman[31,32], Schour and Masseler[33].

CONCLUSION

The present study was conducted to evaluate and correlate skeletal age using CVMI and MP3 among Kanpur individuals. The study sample consisted of a total of 90 subjects 45 boys and 45 girls which was further divided into subgroups A1, B1, C1 and A2, B2, C2 respectively with 15 subjects in each subgroup.

The sample was selected from the outpatient Department of Orthodontics and Dentofacial orthopaedics, Rama Dental College – Hospital And Research Centre, Kanpur in association with the Department of Pedodontics, Preventive Dentistry, Oral Medicine And Radiology. Prior to the commencement of study ethical clearance was obtained from the ethical committee of the institution.

The following conclusions can be drawn from the study:

- The correlation between MP3 and Cervical Vertebral Maturation method was found to be

highly significant for both males and females.

1. Skeletal maturation occurs at an earlier chronological age in females than in males.
2. At the same chronological age, sexual dimorphism exists for both cervical vertebrae maturation and middle phalanx of third finger.
3. There was a statistically significant difference between the two age groups for different indicators and also for both the genders independently.
4. Developmental stages of MP3, are as reliable as CVMI stages for assessment of maturation status of an individual whenever repeated radiographs are required for the assessment of peak in pubertal growth or when lateral cephalogram is not needed at that time.
5. It is feasible to record MP3 stages with standard periapical X-ray film as it can be used as simple, practical and economical method for making decisions on treatment timing.
6. Chronological age is not a reliable indicator for skeletal age.

REFERENCES

1. Garg R, Maniar R, Kambalyal P, Bittu A, Pandya H, Shah K and Makwana B et al. Comparision of skeletal maturity between cervical vertebrae and hand wrist radiograph in the age group 8 to 14 years. JCDS.2013;2:36-43.
2. Tikku T, Khanna R, Sachan K and Agrawal S. Correlation of improved version of cervical vertebral maturation indicator with other growth maturity indicators. J Ind Orthod Soc 2013;47:28-32.
3. Khan RM, Ijaz A. Correlation of Dental Calcification and Skeletal Maturaty Indicators. ANNALS 2011;17:22-26.
4. Krailassiri S, Anuwongnukroh N, Dechkunakorn S.Relationships Between Dental Calcification Stages and Skeletal Maturity Indicators in Thai Individuals. Angle Orthod 2002;72:155–166.
5. Dermijian A, Goldstein H, Tanner J.A new system of dental age assessment. Human Biol.1973;45:2011-2021.
6. Fishman LS. Radiographic evaluation of skeletal maturation. Angle Orthod. 1982;52:88–112.
7. Hassel B, Farman AG. Skeletal maturation evaluation using cervical vertebrae. Am J Orthod Dentofac Orthop. 1995;107:58–66.
8. Hagg Uand Taranger J. Maturation indicators and the pubertal growth spurt.Am J Orthod. 1982;299-309.
9. Flores-Mira C, Burgessb CA, Champneyc M, JensenD RJ, Pitchere MR, Majorf PW. Correlation of Skeletal Maturation Stages Determined by Cervical Vertebrae and Hand-wrist Evaluations. Angle Orthod 2006;76:1–5.
10. Rajagopal R, Kansal S. A Comparison of Modified MP3 Stages and the Cervical Vertebrae as Growth Indicators. JCO. 2002;36:398-406.
11. Baccetti T, Franchi L, McNamara J. An Improved Version of the Cervical Vertebral Maturation (CVM) Method for the Assessment of Mandibular Growth. Angle Orthod 2002;72:316–23.
12. Abdel-Kader HM. The reliability of dental X-ray film in assessment of MP3 stages of the pubertal growth spurt. Am J Orthod 1998;114:427-29.
13. Mira CF ,Burgessb CA, Champneyc M, Jensend RJ, Pitchere MR, Majorf PW. Correlation of Skeletal Maturation Stages Determined by Cervical Vertebrae and Hand-wrist Evaluations. Angle Orthod 2006;76:1–5.
14. Ozer T, Kama JD and Ozer SY. A practical method of determining pubertal growth. Am J Dentofacial Orthop 2006;130:131.e1-131.e6
15. Tofani MI. Mandibular growth at puberty. Am J Orthod 1972;62:176-195.
16. Fishman LS. Chronological versus skeletal age, an evaluation of craniofacial growth. Angle Orthod 1979;49:181-189.
17. So LL. Skeletal maturation of the hand and wrist and its correlation with dental development. Aust Orthod J 1997;15:1-9.
18. Bjork A, Helm S. Prediction of the age of maximum puberal growth in body height. Angle Orthod 1967;37:134-143.
19. Negi KS, Sharma VP, Kapoor DN, Tandon P. Assessment of growth impetus using MP3 maturation and its correlation with CVMI and dental age. J Ind Orthod Soc 2003;36:204-13.
20. Comparitive Evaluation of Modified Mp3 and CVMI as Maturatory Indicators. J Ind Orthod Soc. 2006;39:147-154.
21. Leite RH, Maria TO Reilly, Close JM. Skeletal age assessment using first, second, and third fingers. Am J Orthod Dentofacial Orthop.1987;92:492-508.
22. Tiku T, Khanna R, Sachan K, Aggarwal S. Correlation of Improved Version of Cervical Vertebral Maturation Indicator with Other Growth Maturity Indicators. J Ind Orthod Soc 2013;47(1):28-32
23. Madhu S. Age Estimation Through Finger Radiographs. 2006;06:1-3.
24. Tiku T, Khanna R, Sachan K, Aggarwal S. Correlation of Improved Version of Cervical Vertebral Maturation Indicator with Other Growth Maturity Indicators. J Ind Orthod Soc 2013;47(1):28-32.
25. Bala M, Pathak A. Assessment of skeletal age using MP3 and hand-wrist radiographs and its correlation with dental and chronological ages in children. J Ind Soc Ped and Prev Dent 2010 Apr-Jun;28(2):95-99.
26. Negi KS, Sharma VP, Kapoor DN, Tandon P. Assessment of growth impetus using MP3 maturation and its correlation with CVMI and dental age. J Ind Orthod Soc 2003;36:204-13.
27. Dabla N, Sehgal V, Gupta R, Chanda K and Pradhan K. Comparitive Evaluation of modified MP3 and CVMI stages as Maturation Indicators. J Ind Orthod Soc 2006;39:147-54.
28. Leite RH, Maria TO Reilly, Close JM. Skeletal age assessment using first, second, and third fingers. Am J Orthod Dentofacial Orthop.1987;92:492-508.
29. Prasad M, Suresh V, Ganji K and Shetty SK. Comparison between cervical vertebrae and modified MP3 stages for the assessment of skeletal maturity. J Nat Sci Biol Med 2013;04:74-80.
30. Hunter CJ. The correlation of facial growth with body height and skeletal maturation at adolescence. Angle Orthod. 1966;36:44–5.
31. Fishman LS. Chronological versus skeletal age, an evaluation of craniofacial growth. Angle Orthod. 1979;49:181–9.
32. Fishman LS. Maturational patterns and prediction during adolescence. Angle Orthod. 1987;57:178–93.
33. Schour I, Massler M. The development of the human dentition. J Am Dent Assoc. 1941;28:1153–60.