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Assessment of dental maturation on orthopantomograms among children with various dental malocclusions at a tertiary care hospital

Hafiz Taha Mahmood
Aga Khan University, taha.mahmood@aku.edu

Mubassar Fida
Aga Khan University, mubassar.fida@aku.edu

RESEARCH ARTICLE

Assessment of dental maturation on orthopantomograms among children with various dental malocclusions at a tertiary care hospital

Hafiz Taha Mahmood,[1] Mubassar Fida,[2]

Abstract

Objectives: : To determine and compare the median dental age among males and females and in subjects with dental Class I, II and III malocclusions.

Methods: The retrospective study was conducted at Aga Khan University Hospital and comprised dental records of patients from July to December 2016 who were aged 9-16 years and had complete dentition excluding third molars. The sample was divided according to dental malocclusion which was further categorised according to chronological age groups. SPSS 21 was used for data analysis.

Results: Of the 270 sbjects whose radiographs were studied, 135(50%) each were males and females. Children aged 11-12 years showed a statistically significant difference (p=0.03) in the median dental age among genders. There was a strong positive correlation in the dental and chronological ages in the males (p<0.001) and females (p<0.001) sample. Median time of eruption of mandibular second permanent molar in different malocclusions was 11 years and 2 months.

Conclusion: There was a strong positive correlation between chronological and dental ages for males and females. Females subjects were dentally advanced compared to the male subjects aged 11-12 years. .

Keywords: Dental age, Dental malocclusion, Dental maturation, Demirjian's method. (JPMA 68: 1597; 2018)

Introduction

The aging of the human body can be assessed on the basis of either chronological or biological ages. Chronological age cannot be regarded as a reliable measure of actual age of an individual as the children of the same age could have a variable degree of skeletal maturation.[1] A study[2] defined four pillars of biological age estimation, namely physical examination, social or psychological evaluation, skeletal maturity, and dental age. Estimation of dental age helps us in planning and initiation of comprehensive orthodontic therapy in different malocclusions.[3,4] It helps the pediatricians in the identification of the dental maturity of a child either it has been delayed or advanced. In forensic dentistry, it assists in the identification of the age of the deceased individual and the legislation of the criminal law. It also helps in several other procedures such as employment, social benefits, immigration, etc.[5]

The mineralisation of the tooth indicates the estimated dental age of an individual and can be assessed as the tooth erupts into the oral cavity.[6] Dental age can be evaluated either by visual observation of the eruption of the tooth, histological examination of the dental tissues under the microscope, determination of the alteration of ions level with age in dental hard tissues or radiographically observing the development of teeth.[7]

Eruption of a tooth is an erratic process and can be affected by an array of factors such as under-nutrition, genetic mutation, crowding, ectopic eruption and extraction and ankylosis of the deciduous tooth.[8] However, formation of a tooth is not influenced by the precocious loss of the deciduous tooth.[9] Therefore, tooth formation has been regarded as a more precise indicator of dental age assessment. Various methods have been proposed to evaluate the tooth mineralisation stage using panoramic radiograph,[10] and other methods,[11,12]. Demirjian's method is the most commonly used and has been regarded as the most simple and reproducible method with high precision.[13] It has increased intra-examiner reliability and better accuracy than Nolla's method.[14,15]

The growth of jaws may influence the dental maturity of an individual. Few studies[16,17] have assessed the dental age in different sagittal and vertical malocclusions of the jaws. A study[16] stated that the dental age was more advanced in skeletal Class II and III malocclusions compared to Class I malocclusion individuals. Another study[17] found advanced dental development in skeletal open bite as opposed to deep bite patients.

Currently, there is scarcity of data reporting the dental maturation in different dental malocclusions of an

[1]Resident Year III Orthodontics, [2]Consultant Orthodontist / Associate Professor, Program Director Orthodontics Residency Program, Section of Dentistry, Department of Surgery, The Aga Khan University Hospital, Karachi, Pakistan.

Correspondence: Hafiz Taha Mahmood. Email: taha.mahmood@aku.edu

individual. This report will help clinicians for timely diagnosis, prevention, interception and treatment planning of various dental malocclusions. The current study was planned to compare the mean dental age among males and females and in patients with dental Class I, II and III malocclusions. The secondary objective was to find the mean time of eruption of the second permanent molar in different malocclusions so that comprehensive orthodontic treatment may be initiated involving second permanent molar as well, which would lead us to more favourable and stable results with minimal treatment duration.

Patients and Methods

The retrospective study was conducted at Aga Khan University Hospital, Karachi, and comprised dental records of patients from July to December 2016 who were aged 9-16 years and had complete dentition excluding third molars. Owing to the retrospective nature of the study, exemption was obtained from the institutional ethics committee. The data included related to subjects with chronological age 9-16 years, good quality pre-treatment standardised panoramic radiographs and dental casts, without any missing left permanent mandibular tooth, and without any prior orthodontic treatment history. Data of subjects with any craniofacial anomaly or syndrome, with any systemic illness affecting the development of teeth or with history of trauma to the left seven mandibular teeth excluding the third molars was screened out.

Data were divided into two equal groups along gender lines.

Another categorisation was done according to three dental malocclusions as evaluated on dental casts of the subjects. The maxillary first molar was used to categorise the dental malocclusion as Class I, II and III as proposed by Angle.[18] The sample was further categorised according to four chronological age groups: Group 1: 9-10 years; Group 2: 11-12 years; Group 3: 13-14; and Group 4: 15-16 years.

The panoramic radiographs were evaluated on Rogan Delft View Pro-X (Rogan Delft B.V., Veenendaal, Netherlands) software to assess the dental age of the patient using Demirjian's method.[11] The eight radiographic stages of maturation of the tooth were used to assess the developmental stage of the lower left seven teeth excluding third molars. (Figure 1).

Maturity scores of boys and girls were evaluated separately, and the individual maturity scores from each tooth were then added together to attain the overall maturity score. This score was then used to assess the dental age of the subjects.

Data were analysed using SPSS 21. Shapiro-Wilk test was used to test the normality of the data and it showed non-normal distribution, hence non-parametric tests were used. Mann-Whitney U test was used to compare median dental ages between genders in different chronological age groups. Spearman correlation test was used to find correlation between dental and chronological ages between the genders. Kruskal-Wallis test was applied to compare median dental ages among the three malocclusions in different chronological age groups. Mann-Whitney U test was applied for pair-wise comparison of the median dental ages among males and females in adjacent malocclusion groups and different chronological age groups. To evaluate the median time of eruption of the second permanent molar in three malocclusions, Kruskal-Wallis test was used. $P<0.05$ was considered statistically significant.

The evaluation of Demirjian's score from 30 panoramic radiographs was completed twice by the principal investigator for the evaluation of intra-examiner reliability. The interval between the two readings was kept at 2 months. Kappa statistics were used and there was a

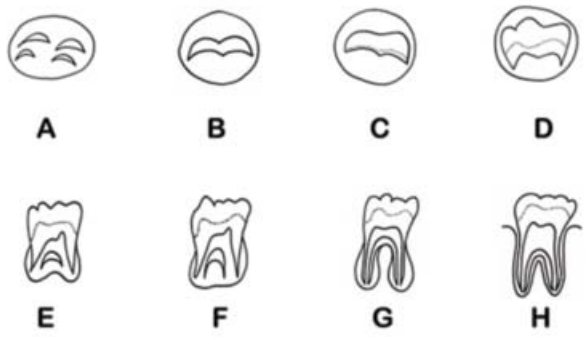

Figure 1: Demirjian's Index for dental age estimation
Stage A: Calcification of single occlusal points without fusion of different calcifications
Stage B: Fusion of mineralization points; the contour of the occlusal surface and dentine formation has commenced
Stage C: Enamel formation has completed at the occlusal surface and dentine formation has commenced. The pulp chamber is curved and no pulp horns are visible.
Stage D: Crown formation has been completed to the level of the cement-enamel junction. Root formation has commenced. The pulp horns are beginning to differentiate, but the walls of pulp chamber remain curved
Stage E: The root length remains shorter than the crown height. The walls of the pulp chamber are straight and the pulp horns have become more differentiated than in the previous stage. In molars, the radicular bifurcation has commenced to calcify
Stage F: The walls of pulp chamber now form an isosceles triangle and the root length is equal to or greater than the crown height. In molars, the bifurcation has developed sufficiently to give the roots a distinct form
Stage G: The walls of the root canal are now parallel, but the apical end is partially open. In molars, only the distal root is rated
Stage H: The root apex is completely closed (distal root in molars). The periodontal membrane surrounding the root and apex is uniform in width throughout

substantial agreement (k=0.804) between the two sets of readings.

Results

Of the 600 dental records scrutinised, 270(45%) comprised the final sample; 135(50%) each related to males and females. In terms of dental malocclusion, data of 100(37%) subjects each was in Class I and II, while there were 70(26%) subjects in Class III. Comparison of median dental age in different chronological age groups and between the genders showed a statistically significant difference in Group 2 aged 11-12 years (p=0.03) (Table 1).

Table-1: Comparison of mean dental ages among genders in different chronological age groups

Age Groups	Male (n=135) (Mean ± SD)	Female (n=135) (Mean ± SD)	p-value
Group 1 (9-10 yrs)	11.1 ± 0.8	11.2 ± 1.4	0.28
FGroup 2 (11-12 yrs)	12.7 ± 1.6	13.1 ± 1.6	0.03*
Group 3 (13-14 yrs)	14.8 ± 2.0	14.9 ± 1.5	0.64
Group 4 (15-16 yrs)	15.9 ± 0.1	15.1 ± 1.8	0.19

N = 270; SD – Standard Deviation; Mann-Whitney U test
* $p \leq 0.05$

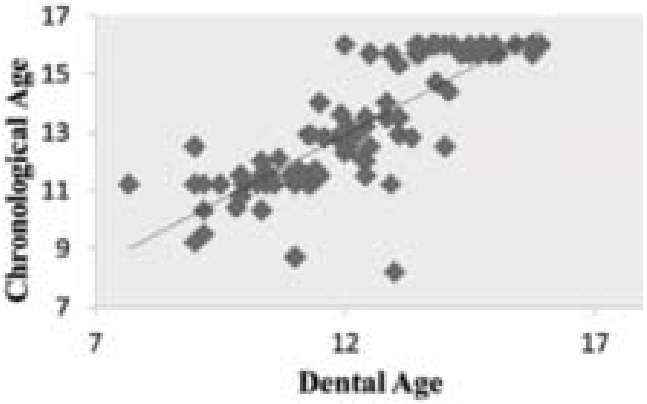

Figure-2: Correlation between dental and chronological age in males
n = 135; Spearman Correlation;
rho = 0.843; p < 0.001

Dental and chronological ages showed a very strong positive correlation (rho=0.84; p<0.001) in males and a strong positive correlation (rho=0.71; p < 0.001) in females (Figures 2-3).

Table-2: Comparison of mean dental ages among genders in three malocclusion groups

Gender	Class I Mean ± SD	Class II Mean ± SD	Class III Mean ± SD	*p* value	Class I & II *p*-value	Class II & III *p*-value	Class I & III *p*-value
Male	13.53 ± 2.30	12.57 ± 2.03	13.64 ± 2.07	0.03*	0.04*	0.03*	0.72
Female	13.41 ± 2.22	13.34 ± 2.15	13.59 ± 2.00	0.86	0.75	0.54	2.29

N = 270; SD – Standard Deviation; Kruskal Wallis test; Mann-Whitney U test
*$p \leq 0.05$

Statistically significant difference was found in median dental age in the male sample in the three malocclusion groups (p=0.03). Pair-wise comparison of the median dental age in the different malocclusion groups showed statistically significant differences in Class I and II and Class II and III groups only in males (Table 2).

There was a statistically significant difference in the Group 3 aged 13-14 years (p=0.05). The subjects of Class I malocclusion in Group 2 were dentally advanced compared to those in the other malocclusion groups. Also, statistically significant difference was found in Class I and II malocclusion group only in the chronological age Group 3 (Table 3).

Table-3: Comparison of mean dental ages among three malocclusions in different chronological age groups

Age Groups	Class I Mean ± SD	Class II Mean ± SD	Class III Mean ± SD	*p*-value	Class I & II *p*-value	Class II & III *p*-value	Class I & III *p*-value
Group 1 (9-10 yrs)	11.36 ± 1.19	11.17 ± 0.91	10.46 ± 1.31	0.13	0.28	0.69	0.50
Group 2 (11-12 yrs)	12.87 ± 2.02	12.92 ± 1.23	12.87 ± 1.35	0.98	0.95	0.87	0.77
Group 3 (13-14 yrs)	15.50 ± 0.88	14.30 ± 2.32	14.74 ± 1.65	0.05*	0.05*	0.51	0.67
Group 4 (15-16 yrs)	15.96 ± 0.10	14.72 ± 2.69	15.50 ± 0.66	0.18	0.72	0.43	0.06

N = 270; SD – Standard Deviation; Kruskal Wallis test; Mann-Whitney U test
*$p \leq 0.05$

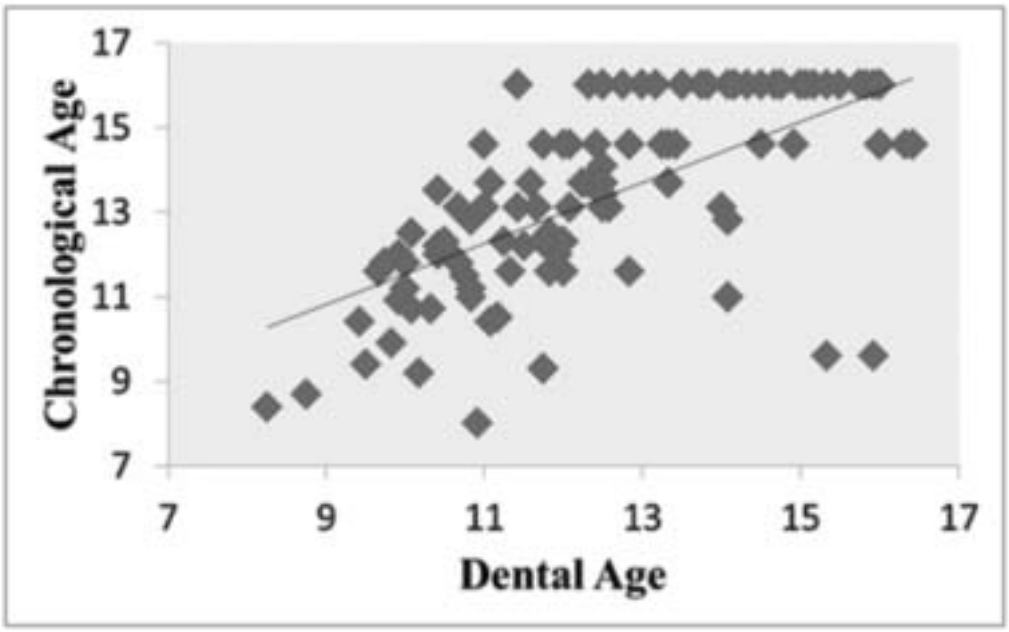

Figure-3: Correlation between dental and chronological age in females
n = 135; Spearman Correlation;
rho = 0.714; p < 0.001

Table-4 Mean time of eruption of mandibular second permanent molar in different malocclusions.

	Dental Malocclusion	Chronological Age (Mean ± SD)(years)	*p*-value
Mandibular Second Molar in F Stage	Class I	11.28 ± 1.08	0.245
	Class II	10.91 ± 0.95	
	Class III	11.48 ± 0.50	
	Total	11.18 ± 0.97	

n = 57; SD – Standard Deviation; Kruskal Wallis test;
$p \leq 0.05$

The average time of eruption of the second permanent molar in Class I malocclusion was 11.28±1.08 years, for Class II malocclusion 10.91±0.95 years, and for Class III malocclusion group 11.48±0.50 years, and the difference was not statistically significant (p=0.245) (Table 4)?

Discussion

Determination of accurate age of an individual is an essential task of a forensic odontologist. By knowing one's accurate age helps us in the assessment of minor and major age status of that individual. It also ensures the decision regarding which court the case should be presented in, and also influences the decision of the jury.[19]

Age estimation is also important for medicolegal purposes because the laws have been set forth for child labour, marriage, driving licenses, and for cases where there is tampering with the documents and even with missing documents, like birth certificate.[20] In addition, it is also necessary for forensic specialists to evaluate the age of human remains, unidentified skeletons and corpses for the proof of identity and credentials.[21] As such, there should be some evidence-based objective method for accurate age assessment of an individual. Dental maturation could be regarded as a more reliable predictor of chronological age because teeth are the only structures in the human body that may persist long, even after most of the skeletal structures have degenerated.[22]

The assessment of dental development is of prime importance when planning and initiating comprehensive orthodontic treatment. Dental development is found to be accelerated or delayed in several dental anomalies, and this should be kept in mind to individually customise and optimise the timing of orthodontic treatment according to a specific patient. A study[23] has reported delayed dental maturation in subjects with buccal or palatally impacted canines. Delayed dental maturation is also found to be associated with agenesis of second premolar,[24] cleft lip and palate,[25] cliedocranial dysplasia[26] and various other syndromes.

Various studies have reported the dental development process in sagittal[16,27]and vertical[17,28] skeletal relationships and also the association between skeletal maturation and dental development.[29] However, to our knowledge, no study has yet reported the dental maturation in various dental malocclusion groups. Hence, the current study was planned to fill that gap by determining dental maturation among male and female subjects with dental Class I, II and III malocclusions.

According to a study,[27]dental development and

chronological age may not show linear relationship and there exists a gender dimorphism related to dental maturation. It found 0.33 years' difference in males and 0.94 years' difference in females in dental maturation and chronological age. A study[30] in Romania reported that the dental development was advanced in all age groups for girls compared to their chronological age. However, the chronological age was advanced compared to the dental age in all age groups in boys, except the age groups: 5.5-6.4, 6.5-7.4 and 13.5-14.4 years. We found that the dental age was ahead compared to the chronological age in all age groups in males and females except Group 4 aged 15-16 years. In addition, we also found that the females in the chronological age Group 2 were dentally more advanced (p=0.03) compared to the males. This is due to the fact that puberty arises earlier in females compared to the males and, therefore, orthodontic treatment should commence earlier in females.

Among the three classes of malocclusion, we found statistically significant difference in the dental maturation in males and chronological age Group 3. Moreover, the subjects of Class I malocclusion only, in the chronological age Group 3 were found to be dentally advanced compared to the other malocclusion groups.

A study conducted in Caucasian boys[31] has reported moderate positive correlation (r=0.68) between chronological age and dental age. Another study[32] has reported very strong positive correlation (r=0.82) in males and females. One study[33] in India reported strong positive correlation in males (r=0.98) and females (r=0.98) between chronological and dental age. Our study also found very strong positive correlation in males (r=0.84) and strong positive correlation in females (r=0.71).

The timing of eruption of the second permanent molar is of considerable importance in clinical orthodontics because it helps in the initiation and planning of various dental malocclusions e.g. patients with severe deep bite and open bite malocclusions, mesialisation of second molar in first molar extraction site or in maximum anchorage situations where involvement of second molars is also planned. Usually, comprehensive orthodontic treatment is initiated when the second permanent molars have also erupted so that they are also incorporated in the treatment. This would lead to reduced overall duration of treatment and a more stable, favourable and aesthetic result. We found that the median time of eruption of the second permanent molar in different malocclusions was 11 years and 2 months, so comprehensive orthodontic treatment can be initiated beyond this period in any dental malocclusion subject.

The clinical implication of our study is that in patients with delayed dental maturity, comprehensive orthodontic treatment should be started at a later stage, which will lead to shorter treatment duration.

The limitations of the current study is its single-centre orientation. Also, the Demirjian's method cannot be used for dental age estimation in subjects beyond 16 years. As the method is attributed to French-Canadian population, we recommend a multi-centre study using dental maturation norms of our population. For the estimation of dental maturation in adult population, newer methods have been proposed using techniques like aspartic acid racemisation and translucent dentine and they have shown high accuracy in adult age assessment.[34]

Conclusion

There was a strong positive correlation between chronological and dental ages for males and females. Females subjects were dentally advanced compared to the male subjects aged 11-12 years. Statistically significant difference was found in the dental age in males and chronological ages 13-14 years among the three malocclusion groups.

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Reference

1. Finkel D, Whitfield K, McGue M. Genetic and environmental influences on functional age: a twin study. J Gerontol B Psychol Sci Soc Sci 1995; 50: 104-13.
2. Black S, Aggrawal A, Payne James J. Age Estimation in the Living: The Practitioner's Guide. USA: Wiley Blackwell; 2010.
3. Maber M, Liversidge HM, Hector MP. Accuracy of age estimation of radiographic methods using developing teeth. Forensic Sci Int 2006; 159: 68-73.
4. Koshy S, Tandon S. Dental age assessment: the applicability of Demirjian's method in south Indian children. Forensic Sci Int 1998; 94: 73-85.
5. Flores AP, Sanhueza MA, Barboza P, Monti CF. Study of Chilean children's dental maturation. J Forensic Sci 2010; 55: 735-7.
6. Gustafson G, Koch G. Age estimation up to 16 years of age based on dental development. Odontol Rev 1974; 25: 297-306
7. Shamim T. Age estimation: a dental approach. J Punjab Acad Foren Med Toxicol 2006; 6: 14-6.
8. Sierra AM. Assessment of dental and skeletal maturity: a new approach. Angle Orthod 1987; 57: 194-208.
9. Sapoka AA, Demirjian's A. Dental development of the French Canadian child. J Can Dent Ass 1971; 37: 100-4.
10. Nolla CM. The development of permanent teeth. University of Michigan; 1952.
11. Demirjian's A, Goldstein H, Tanner JM. A new system of dental age assessment. Hum Biol 1973; 1: 211-27.
12. Willems G, Van Olmen A, Spiessens B, Carels C. Dental age estimation in Belgian children: Demirjian's technique revisited. J Forensic Sci 2001; 46: 125-7.

13. Khoja A, Fida M, Shaikh A. Validity of different dental age estimation methods in Pakistani orthodontic patients. Aust J Forensic Sci 2015; 47: 283-92.
14. Leurs IH, Wattel E, Aartman IH, Etty E, Prahl-Andersen B. Dental age in Dutch children. Euro J Orthod 2005; 27: 309-14.
15. Sinha S, Umapathy D, Shashikanth MC, Misra N, Mehra A, Singh AK. Dental age estimation by Demirjian's and Nolla's method: A comparative study among children attending a dental college in Lucknow (UP). J India Acad Oral Med Radiol 2014; 26: 279-86.
16. Celikoglu M, Erdem A, Dane A, Demirci T. Dental age assessment in orthodontic patients with and without skeletal malocclusions. Orthod Craniofac Res 2011; 14: 58-62.
17. Janson GR, Martins DR, Tavano O, Dainesi EA. Dental maturation in subjects with extreme vertical facial types. Eur J Orthod 1998; 20: 73-8.
18. Angle EH. Treatment of malocclusion of the teeth: Angle's system. 7th ed. Philadelphia: White Dental Manufacturing Company; 1907.
19. Verma AK, Kumar S, Rathore S, Pandey A. Role of dental expert in forensic odontology. Natl J Maxillofac Surg 2014; 5: 2-5
20. Sweet D. Why a dentist for identification? Dent Clin North Am 2001; 45: 237-51.
21. Karaarslan B, Karaarslan ES, Ozsevik AS, Ertas E. Age estimation for dental patients using orthopantomographs. Euro J Dent 2010; 4: 389-94
22. Reppien K, Sejrsen B, Lynnerup N. Evaluation of post mortem estimated dental age versus real age: A retrospective 21 year survey. Forensic Sci Int 2006; 159: 84-8.
23. Rozylo-Kalinowska I, Kolasa-Raczka A, Kalinowski P. Dental age in patients with impacted maxillary canines related to the position of the impacted teeth. Euro J Orthod 2011; 33: 492-7.
24. Hirsch A, Dannhauer KH, Gelbrich G. Agenesis of second premolars and delayed dental maturation. J Orofac Orthop 2015; 76: 338-50.
25. Tan ELY, Yow M, Kuek MC, Wong HC. Dental maturation of unilateral cleft lip and palate. Ann Maxillofac Surg 2012; 2: 158-62
26. Ritz-Timme S, Cattaneo C, Collins MJ, Waite ER, Schütz HW, Kaatsch HJ, et al. Age estimation: the state of the art in relation to the specific demands of forensic practice. Int J Legal Med 2000; 113: 129-36.
27. Esenlik E, Atak A, Altun C. Evaluation of dental maturation in children according to sagittal jaw relationship. Euro J Dent 2014; 8: 38-43
28. Sukhia RH, Fida M. Dental maturity amongst various vertical and sagittal facial patterns. J Coll Physicians Surg Pak 2010; 20: 225-8
29. Uysal T, Sari Z, Ramoglu SI, Basciftci FA. Relationships between dental and skeletal maturity in Turkish subjects. Angle Orthod 2004; 74: 657-64.
30. Ogodescu AE, Ogodescu A, Szabo K, Tudor A, Bratu E. Dental Maturity a biologic indicator of chronological age: digital radiographic study to assess dental age in Romanian children. Int J Biol Biomed Eng 2011; 5: 32–40.
31. Green LJ. The interrelationships among height, weight and chronological, dental and skeletal ages. Angle Orthod 1961; 31: 189-93.
32. Sukhia RH, Fida M. Correlation among chronologic age, skeletal maturity, and dental age. World J Orthod 2009; 11: 78-84.
33. Hegde RJ, Sood PB. Dental maturity as an indicator of chronological age: radiographic evaluation of dental age in 6 to 13 years children of Belgaum using Demirjian's methods. J Indian Soc Pedod Prev Dent 2002; 20: 132-8.
34. Avon SL. Forensic odontology: the roles and responsibilities of the dentist. J Can Dent Assoc 2004; 70: 453-8.