Original Article

Assessment of skeletal and dental maturity indicators and comparison of maturity indicators in vertical and horizontal growth pattern individuals with normal growth pattern individuals

ABSTRACT

Objective: The purpose of the present study was carried out to establish whether the vertical and horizontal growth patterns influence the rate of dental and skeletal maturation as compared to normal growth patterns.

Materials and Methods: This study comprised sixty samples divided into three groups. Group I normal grower (control), Group II-vertical growers, and Group III-horizontal growers. Each sample was assessed for skeletal and dental age using cervical vertebrae maturation index (CVMI), skeletal maturity indicator stages and canine calcification stages, respectively. All data in the groups were analyzed by analysis of variance test. Subgroup data and comparisons were analyzed by Dunnett D-test and -test.

Results: Results showed that dental maturation was delayed in horizontal growers as compared to vertical growers with = 0.00 and 0.044. There was nonsignificant difference in dental maturation of male and females with >0.05. The comparison of skeletal maturation by hand-wrist radiograph showed significant variation in Group III with delayed skeletal maturation of horizontal growers than control group with $P < 0.05$. Dunnett D-test showed main skeletal age by CVMI was significant with = 0.00 which indicates that skeletal age of Group III to be lower in all groups. Rest was nonsignificant.

Conclusion: Individuals with horizontal growth pattern showed delayed dental maturation when compared to vertical growers.

Keywords: Cervical vertebrae maturation index, dental age, skeletal age, skeletal maturity indicator

INTRODUCTION

The assessment of maturational status is a decisive factor in diagnosis, treatment planning, and the eventual outcome of orthodontic treatment. Assessing maturational status is more important when the clinical considerations are based strongly on the increased or decreased rates of craniofacial growth left, such as the timing and use of extraoral traction and the use of functional appliances. Furthermore, it helps in predicting future growth potential of the facial skeleton to ensure the successful outcome of the treatment of dentofacial deformities.[1] Racial and sexual differences and other less tangible factors such as climate, nutrition, socioeconomic levels, and urbanization may influence the rates of physiologic maturity of a child. This renders the chronological age as an unreliable indicator of maturational levels.[2] The hand-wrist radiograph is commonly used for the assessment of skeletal

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development as many investigators have found a significant correlation between maturation stages.[2-6] Also, changing concavities in the lower border of cervical vertebrae are also found to be a reliable method for assessing skeletal development apart from hand wrist.[7-12] Coutinho *et al*.[13] found a close relationship between the canine calcification stage G in the mandible with the pubertal growth spurt. However, it remains questionable whether association based on dental stages are strong enough to make reliable clinical predictions. The difference in dental maturation between skeletal open bite and skeletal deep bite individuals was investigated by Janson *et al*.[14] and reported that skeletal open bite individuals presented a slight tendency to have an advanced dental maturation expressed by the dental age. Nanda, and Rowe[15] also concluded that timings of the adolescent growth spurt for various facial dimensions in open bite faces were earlier than deep bite faces. In addition, studies conducted by different investigators to assess the correlation between different facial types, i.e. skeletal open bite and skeletal deep bite on dental maturation have shown that there is a difference in the timings of dental maturation between these extreme vertical facial types. The timing of craniofacial growth and its relationship to other developmental events presents a particular challenge in individuals exhibiting variations in facial form. Considering the lack of data on variability of skeletal maturation between the two facial types, the present study was carried out to establish whether the vertical and horizontal growth patterns influence the rate of dental and skeletal maturation as compared to normal growth patterns. Furthermore, the study probed any sexual dimorphism on the rate of dental and skeletal maturation between the vertical and the horizontal growers.

MATERIALS AND METHODS

The study consisted of sixty individuals of chronological ages between 8 and 14 years. Selection criteria include individuals with no history of bony deformities and pathosis, no muscular dystrophy, congenital abnormalities, traumatic injuries to the jaws and hands. Approval from Ethical Committee of Datta Meghe Institute of Medical Sciences Deemed University was taken before the study. Lateral cephalogram, orthopantomogram (OPG) (PlanmecaProline and Vision 100A) and hand-wrist radiographs were taken for each sample. Mandibular plane angle was used to divide the samples into three groups, i.e. Group I (normal growers-control group), Group II (vertical growers), and Group III (horizontal growers). Group II and Group III were further subdivided into two subgroups as subgroup A (males) and B (females).

All the samples were evaluated for their respective stages of skeletal and dental maturation as per the methods developed by Fishman for skeletal maturity indicator (SMI) stages using hand-wrist radiographs, for cervical vertebrae maturation index (CVMI) stages using lateral cephalogram.[8] Demirjian *et al*.[16] index was used to assess dental age using OPG.

RESULTS

The mean chronological age for Groups I, II, and III was 10.90 ± 0.47, 10.14 ± 0.98, and 10.24 ± 1.45, respectively [Table 1].

The analysis of variance (ANOVA) (one-way ANOVA test) showed that there exists statistically significant variation in all the three types of growth patterns with $P < 0.05$ (0.00). Multiple comparison Dunnet D-test showed that mean dental age of Group III was lowest followed by Group II as compared with $P = 0.00$ and 0.044, respectively [Table 2].

Independent *t*-test showed statistically significant variation with $P = 0.01$, suggestive of delayed dental maturation in horizontal growers when compared to vertical growers [Table 3].

Dental maturation in subgroups was found to be significant with *P* value >0.05 (0.01) suggestive of female vertical growers to be ahead in growth spurt as compared to male

Table 1: Mean dental age (years) in three groups (descriptive statistics)

Group	*n*	Mean±SD	SE	95% CI		Minimum	Maximum
				Lower bound	Upper bound		
Group III	20	9.66±1.46	0.32	8.97	10.35	7.30	12.40
Group II	20	10.67±1.02	0.23	10.18	11.15	7.90	12.40
Group I	20	11.49±0.74	0.16	11.14	11.84	10.00	12.50

SE: Standard error, SD: Standard deviation, CI: Confidence interval

Table 2: Mean dental age (multiple comparison Dunnett D-test)

Group	Mean difference (I-J)	SE	*P*	95%CI	
				Lower bound	Upper bound
Group III	−1.86	0.35	0.000 S, *P*<0.05	−2.63	−1.02
Group II	0.82	0.35	0.044 S, *P*<0.05	−1.63	−0.01

SE: Standard error, CI: Confidence interval, S: Significant

Table 3: Results of independent *t*-test between dental ages of vertical (Group II) and horizontal group (Group III)

Variable	Mean±SD		Difference	*P*
	Group II	Group III		
Dental age	10.67±1.04	9.66±1.46	−1.00	0.01 S, *P*<0.05

SD: Standard deviation, S: Significant

vertical growers. However, the present study showed no significant difference in dental maturation in female horizontal growers [Table 4].

Horizontal growers, when compared to normal growers, showed delayed skeletal maturation whereas no significant variation in skeletal maturation was seen when vertical growers were compared to normal growers [Table 5].

Independent *t*-test showed that the skeletal age is ahead in Group II as compared to Group III but with statistically nonsignificant ($P > 1.77$) [Table 6]. Suggestive of nonsignificant variation in skeletal maturation when horizontal growers were compared to vertical growers.

A significant difference between males and females was found in subgroup II with $P < 0.05$ (0.04) suggestive of male vertical growers being ahead of skeletal maturation when compared to female vertical growers [Table 7].

Multiple comparison Dunnet D-test showed mean skeletal age of Group III to be lowest followed by Group II and was statistically significant with $P = 0.00$ and 0.003, respectively, when compared with Group I [Table 8].

Table 4: Results of independent *t*-test in horizontal and vertical subgroups (male and female)

Group	Mean±SD		Difference	*P*
	Subgroup A	Subgroup B		
Group III	9.89±0.76	9.44±1.96	0.45	0.50 NS, $P>0.05$
Group II	10.08±0.99	11.16±0.77	−1.08	0.01 S, $P<0.05$

SD: Standard deviation, S: Significant, NS: Not significant

Table 5: Multiple comparison within groups: Dunnett D-test (skeletal maturation indicators with hand wrist)

Group	Mean difference (I-J)	SE	*P*	95% CI	
				Lower bound	Upper bound
Group III	−0.99	0.28	0.002 S, $P<0.05$	−1.62	−0.35
Group II	−0.45	0.28	0.20 NS, $P>0.05$	−1.08	0.18

S: Significant, NS: Not significant, SE: Standard error, CI: Confidence interval

Table 6: Results of independent *t*-test between skeletal ages of Group II and Group III using skeletal maturation indicators

Variable	Mean±SD		Difference	*P*
	Group II	Group III		
Skeletal I age	11.64±1.03	11.10±0.88	−0.54	0.08 NS, $P>0.05$

NS: Not significant, SD: Standard deviation

In addition, no significant variation in skeletal maturation was observed when horizontal growers were compared to vertical growers [Tables 9 and 10].

DISCUSSION

The present study showed results which are comparable to those of Neves *et al*.[17] showing early maturation and a more advanced dental age for the vertical growers with the mean difference of 1.00 as compared to horizontal growers. Also Janson *et al*.[14] studied the differences in dental maturation between skeletal open and deep bite individuals in forty individuals with mean of 9.2 years and reported that skeletal open bite individuals have advanced dental maturation, expressed by dental age, as compared to skeletal deep bite individuals. Dental maturation in subgroups was found to be significant with *P* value > 0.05 (0.01) suggestive of female vertical growers to be ahead in growth spurt as compared to male vertical growers. However, the present study showed no significant difference in dental maturation in female horizontal growers. This is comparable with the results of Nanda[18] who conducted a study on 16 males and 16 females and reported that female open bite individuals were earlier in timing of adolescent growth spurt than the male open

Table 7: Results of independent *t*-test for skeletal age between subgroups (using skeletal maturation indicators)

Group	Mean±SD		Difference	*P*
	Subgroup A	Subgroup B		
Group III	11.24±0.50	10.97±1.16	0.27	0.50 NS, $P>0.05$
Group II	12.10±1.11	11.19±0.75	0.91	0.04 S, $P<0.05$

SD: Standard deviation, NS: Not significant, S: Significant

Table 8: Multiple comparison within group: Dunnett D-test (cervical vertebrae maturation indicators)

Group	Mean difference (I-J)	SE	*P*	95% CI	
				Lower bound	Upper bound
Group III	−1.41	0.30	0.000 S, $P<0.05$	−2.10	−0.72
Group II	−1.00	0.30	0.003 S, $P<0.05$	−1.68	−0.31

S: Significant, SE: Standard error, CI: Confidence interval

Table 9: Results of independent *t*-test between skeletal ages (cervical vertebrae maturation indicators) of vertical and horizontal group

Variable	Mean±SD		Difference	*P*
	Group II	Group III		
Skeletal I age	10.60±0.98	10.19±0.98	−0.41	0.19 NS, $P>0.05$

SD: Standard deviation, NS: Not significant

Table 10: Results of independent *t*-test between skeletal age between subgroups (using cervical vertebrae maturation indicators)

Group	Mean±SD		Difference	*P*
	Subgroup A	Subgroup B		
Group III	9.77±0.71	10.61±1.07	−0.84	0.05 NS, *P*>0.05
Group II	10.41±1.15	10.80±0.78	−0.39	0.39 NS, *P*>0.05

SD: Standard deviation, NS: Not significant

bite individuals comparison of skeletal maturation in all three groups: A clinical implication of these results is that orthodontic treatment of patients with an open bite may begin earlier than in those with a horizontal pattern, not only because their pubertal facial growth spurt manifests earlier, but also because tooth calcification and subsequent eruption may occur earlier. This is especially true for fixed appliance that depends on the eruption of the second molars during the initial stages of treatment. In contrast, patients with a predominantly horizontal facial pattern may have their treatment started later since the pubertal facial growth spurt will occur later, as well as tooth calcification and eruption.

CONCLUSION

Following conclusions were drawn:

1. Dental maturation in vertical and horizontal growing individuals using OPG:
   - Individuals with horizontal growth pattern showed delayed dental maturation when compared to vertical growers
   - Female vertical growers are ahead of males in dental maturation.
2. Skeletal maturation in vertical and horizontal growing individuals using SMI and CVMI:
   - Although it was found that horizontal growth pattern individuals showed a delay in skeletal maturation when compared to vertical growers, the difference was not statistically significant
   - Female vertical growers have advanced skeletal maturation than male vertical growers.
3. Skeletal maturation in vertical and horizontal growing individuals using CVMI in lateral cephalogram:
   - Although female vertical and horizontal growers have advanced skeletal maturation, the difference was not statistically significant.

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Conflicts of interest

There are no conflicts of interest.

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