European Journal of Orthodontics 20 (1998) 73–78

Dental maturation in subjects with extreme vertical facial types

Guilherme R. P. Janson*, Décio Rodrigues Martins*, Orivaldo Tavano** and Eduardo A. Dainesi*

Departments of *Orthodontics and **Radiology, Bauru Dental School, University of São Paulo, Brazil

SUMMARY The purpose of this research was to investigate whether there is a difference in dental maturation between skeletal open bite and skeletal deep bite subjects of the same chronological age.

The material consisted of 40 lateral headfilms and 40 panoramic radiographs of 20 male and 20 female white subjects, with a mean chronological age of 9 years and 2 months (range: 7 years 6 months to 10 years 11 months). These subjects were selected on the basis of lower anterior face height as a percentage of total face height and on the amount of open or deep-bite from a total sample of 400 subjects. The persons exhibiting the most extreme values at both ends of the distribution were selected to create two groups with 20 subjects in each (10 males and 10 females). Thus, the groups represented subjects with either a large lower anterior face height associated with an open bite or a small lower anterior face height associated with a deep bite.

A double blind determination of dental maturation, expressed by dental age, for each subject was performed on the panoramic radiographs using the system of Demirjian *et al.* (1973). A covariance analysis was used to eliminate variability introduced by the large age range of the sample.

The skeletal open bite and deep bite groups presented mean dental ages of 120.48 and 114.00 months, respectively. Statistical analysis demonstrated that this difference was statistically significant at $P < 0.05$. Therefore, it seems that skeletal open bite subjects presented a slight tendency to have an advanced dental maturation, expressed by dental age, as compared with skeletal deep bite subjects.

Introduction

There is a general factor of skeletal maturity that results in a tendency for an individual to be advanced or delayed (Tanner, 1962). Several studies have found a positive correlation between skeletal, somatic, and sexual maturity (Demirjian *et al.*, 1985). However, regarding the correlation between the dental and skeletal development, Demirjian *et al.* (1985) and Mappes *et al.* (1992) found these events to be independent, while Lamons and Gray (1958) and Green (1961) found a positive, but low correlation (r = 0.77 and r = 0.46, respectively). Gleiser and Hunt (1955) verified that a delay in the ossification of the bones of the hand and wrist often coincides with a lag of tooth formation. Others have tried to relate the dental eruption stages with the pubertal events and found a low correlation (r = 0.35; Hägg and Taranger, 1982), since the onset of dental eruption presents a large variability and is under great environmental influence (Demirjian, 1978). Other studies have demonstrated that some teeth present a smaller variability in their calcification stages and, consequently, a higher correlation with the skeletal developmental stages. Garn *et al.* (1962) demonstrated only low correlations (r = 0.41) between lower third molar development and skeletal development. Demish and Wartmann (1956) and Engström *et al.* (1983) found a higher correlation (r = 0.83 and r = 0.72, respectively). Chertkow (1980) and Coutinho *et al.* (1993) verified that there was a high correlation (r = 0.88 and r = 0.85, respectively) between the calcification stages of the lower canine and pubertal events, and suggested the use of this tooth as an indicator of the maturational stages and of the pubertal growth spurt. Sierra (1987) found that there was a high correlation (r = 0.82) between the least variable ossification centres of the hand and wrist and dental calcification stages. Consequently, she suggested the use of the calcification status (dental age), particularly of the lower canine, to estimate skeletal development of orthodontic patients who fall within an essentially normal developmental range.

When studying subjects with either skeletal open bite or deep bite, Nanda, in 1988, evidenced a difference in the timing of the facial adolescent growth spurt between these extreme vertical facial types. Subjects with a skeletal open bite presented the onset of the adolescent growth spurt in the facial measurements earlier than those with a deep bite.

The clinical experience of the authors suggested that subjects with a predominantly deep bite presented a delay in dental development in relation to others. The literature shows that dental development in subjects with extreme vertical facial types has not been studied. Since the pubertal growth spurt presents some degree of correlation with dental development, as demonstrated above, and a difference in the onset of the facial pubertal growth spurt has been shown in subjects with skeletal deep and open bite (Nanda, 1988), this study was designed to investigate whether subjects with a skeletal deep bite present a delay in dental development in relation to subjects with a skeletal open bite, by comparing dental maturation, expressed by dental age, between skeletal open bite and skeletal deep bite subjects of the same chronological age.

Materials and methods

The sample was obtained from the files of the Orthodontic Clinic at Bauru Dental School, University of São Paulo, and consisted of 40 lateral cephalometric headfilms and 40 panoramic radiographs of 20 male and 20 female white subjects with a chronological age ranging from 7 to 10 years (mean = 9 years 2 months) that presented the lower anterior face height disproportionately large or small, associated with an open or deep bite, respectively. The radiographs were taken before the beginning of orthodontic therapy (Figure 1).

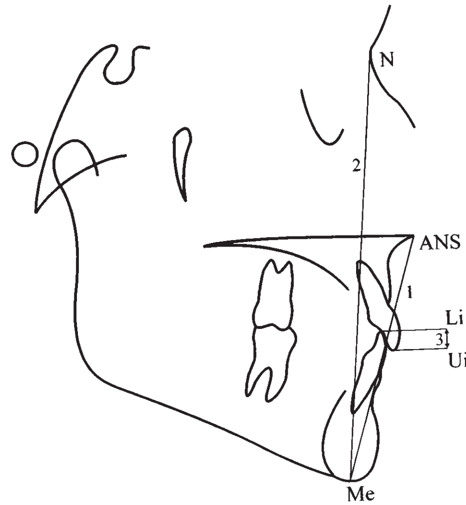

Figure 1 Landmarks and measurements: anterior nasal spine (ANS); nasion (N); menton (Me); incisal edge of the upper incisor (Ui); incisal edge of the lower incisor (Li). (1) Lower anterior face height (LAFH), anterior nasal spine to menton (ANS–Me). (2) Total anterior face height (TAFH), nasion to menton (N–Me). (3) Vertical overbite (VO), the vertical distance from the incisal edge of the upper incisor to the incisal edge of the lower incisor (Ui–Li).

Classification criteria

The sample was drawn from a total of 400 subjects, based on the percentage of lower anterior face height (LAFH) to total anterior face height (TAFH) and on the amount of vertical overbite. The subjects with extreme values at both ends of the distribution were divided in two groups, with 20 subjects (10 male and 10 female) in each. Therefore, these groups represent subjects with either a disproportionately large lower anterior face height associated with an open bite or with

Table 1 Percentage of LAFH/TAFH and vertical overbite means and standard deviations for the sample.

Facial type	LAFH/TAFH		Vertical overbite	
	Mean	SD	Mean	SD
Open bite	59.40	2.56	–1.00	1.87
Deep bite	55.85	2.51	4.80	1.70

a disproportionately small lower anterior face height associated with a deep bite. To allow intergroup comparison, care was taken to select subjects of the same gender with the most similar age possible, in each group. Thus, for a given male subject aged 8 years 5 months, in the skeletal open bite group, there was a correspondent in the skeletal deep bite group. The means and standard deviations for the sample are represented in Table 1.

Dental maturity score and dental age determination

Dental age is defined as the estimated age of the subject based on the level of tooth mineralization or calcification during the developmental process (Gustafson and Koch, 1974). A double blind dental maturity score and dental age determination was carried out independently by two examiners, calibrated through daily exercises on the panoramic radiographs, using the system of Demirjian *et al.* (1973). The left lower quadrant, from central incisor to second molar (or the side with the best quality image) was used. The system attributes a maturity score for each tooth. The summed scores on all seven teeth give a dental maturity score which is converted directly into a dental age. Chronological and dental age were expressed in months (Table 2).

Statistical analysis

Means and standard deviations were calculated for each group. A covariance analysis was used to eliminate the variability introduced by the large age range of the groups. When planning clinical research, one has to establish what would be a clinically significant difference between the groups. In terms of treatment time, it can be stated that a 6-month difference is clinically significant for the patient, as well as for the orthodontist. Therefore, taking 6 months as clinically significant, at a significance level of 5 per cent, with a sample size of 20 subjects, the power of the statistical test is 80 per cent (Marks, 1985).

Results

Table 2 shows the dental ages for the genders separately and combined. It can be seen that dental age had a tendency to be more advanced in both genders in the skeletal open bite groups as compared with the skeletal deep bite groups. When the genders were combined, the skeletal

Table 2 Dental maturity scans with respect to overbite.

	Dental age (months)	SD	SE	Max	Min	Chron. age (months)	SD	SE	Max	Min
Skeletal open bite										
Male	125.76	21.50	6.80	153.60	96.00	113.10	13.50	4.26	131.00	92.00
Female	115.20	18.60	5.88	150.00	91.20	107.70	11.56	3.65	128.00	93.00
Total	120.48	20.31	4.54	153.60	91.20	110.40	12.54	2.80	131.00	92.00
Skeletal deep bite										
Male	119.52	16.78	5.30	150.00	98.40	114.10	13.27	4.19	136.00	95.00
Female	108.48	15.20	4.80	139.20	92.40	107.80	10.73	3.39	127.00	94.00
Total	114.00	16.58	3.70	150.00	92.40	110.95	12.18	2.72	136.00	94.00

open bite and the skeletal deep bite groups presented mean dental ages of 120.48 and 114.00 months, respectively. The covariance analysis demonstrated that this difference was statistically significant at $P < 0.05$. Comparable chronological age in all related groups confirms the similarity of the sample. All groups presented large standard deviations, as expected, due to the large chronological age range of the sample. These large standard deviations were compensated for by use of covariance analysis.

Discussion

Dental age was used to express dental maturation because it is clinically easily recognizable. The maturity scoring system used is probably universal, but some criticism may arise regarding the conversion to dental age for the sample in this study, since it was developed for a different population. However, this study was not concerned with estimating the actual chronological age of the subjects, but rather its objective was to evaluate whether there was a difference in dental maturation, expressed in terms of dental age, between the two groups.

The result shows that there is a statistically significant difference in dental development in subjects with extreme vertical facial types. Indirectly, additional support is provided to the findings of Shuttleworth (1939) who reported that girls with an early peak height velocity are more advanced in dental emergence. Since the skeletal open bite group presents an advanced facial maturation (Nanda, 1988), it would be expected that the dental maturation would also be advanced. Although there is divergence over the occurrence of a facial pubertal growth spurt, it has been documented in several studies (Brown *et al.*, 1971; Grave, 1973; Thompson and Popovich, 1973; Mitani, 1977; Baughan *et al.*, 1979; Fishman, 1982; Lewis *et al.*, 1985; Nanda, 1988). Considering this background and the relationship, although low, between dental and skeletal development reported in the literature, the question regarding a possible difference in dental development in subjects with different vertical facial types is not unfounded. One should also consider that, for an individual analysis, a low correlation between dental and skeletal development is not relevant, but is meaningful for a sample analysis. Subjects with a predominantly skeletal deep bite presented a delayed dental maturation as compared with the skeletal open bite group. There was a 6-month difference in dental age between the two groups (Table 2) that is statistically significant according to the covariance analysis. This analysis was used to eliminate the variability introduced by the large chronological age range of the groups. However, this result has to be analysed with caution due to the small sample size and the large age range. Moreover, one has to consider if a 6-month difference is in fact clinically significant. As stated above, if one considers treatment time, a 6-month difference is clinically significant. The ideal, in this type of investigation, would be to use a larger and more uniform sample regarding chronological age. However, when rigid criteria are used to obtain groups of subjects with completely different vertical facial types, the sample is considerably reduced. Note that the groups were selected from 400 subjects. The use of such rigid criteria is essential to reduce the possibility of including in the groups subjects with hybrid facial characteristics that could reduce the differences between the groups. Table 2 allows a more detailed comparison of the sample. There is a balance in the chronological ages in both groups. The male deep bite group presents a chronological age that is a month older than the male open bite group, but nevertheless, the dental age obtained was smaller. No statistical analysis was performed between groups of the same gender due to the small sample size. Since the groups presented the same number of subjects for each gender, the statistical analysis could be performed without major concerns regarding sexual dimorphism.

The explanation for an advanced dental maturation in subjects with a skeletal open bite, in relation to those with a skeletal deep bite, is mainly based on the intrinsic characteristics of the facial shape and genetic background (Garn *et al.*, 1960). Nanda and Rowe (1989) studied the correlation between maximum facial growth and the onset of menarche, and found that the subjects with an open bite presented a correlation between these events, while those with a deep bite did not. Considering the results of previous studies (Nanda, 1988; Nanda and Rowe, 1989), that demonstrated a difference in facial maturational timing between subjects with skeletal open bite and deep bite, it would seem logical to expect a difference in dental maturation, as evidenced in the present investigation. Moreover, there is evidence to show that facial growth patterns in subjects with extreme variation in facial shape, or in occlusal relationship, are not the same as in subjects with a normal facial shape (Nanda and Rowe, 1989). Therefore, the observed difference in dental maturation between these extreme vertical facial types may be a manifestation of a dissimilarity of their facial growth patterns.

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 (Nanda, 1988; Nanda and Rowe, 1989), but also because tooth calcification and subsequent eruption may occur earlier. This is especially true for fixed appliance techniques that depend 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.

This result points to vertical facial types as another, among the several other well-known factors (Tanner, 1962; Niswander, 1963; Garn *et al.*, 1965; Eveleth, 1966), that contribute to dental age variability. Additional consideration is that the application of biological age determination dental tables may be misleading if no consideration is given to the individual vertical facial type. Furthermore, the use of chronological age overestimates the dental maturity of skeletal deep bite subjects and, consequently, underestimates the growth potential. Growth prediction methods usually do not consider the fact that subjects with less maturation present a larger growth potential and also are in different phases of their growth curves (Johnston, 1975; Schulhof, 1978).

Obviously, the results obtained in this study are not conclusive, due to the small sample size, and should be regarded as a slight trend in dental development in these different facial types. Despite attributing this difference in dental maturation, between the two extreme vertical facial types to the individual characteristics in each type, future studies are necessary to elucidate precisely the reason for this variation.

Conclusion

The results suggest a difference in dental maturation, expressed by dental age, in subjects with extreme vertical facial types; subjects with a skeletal open bite present a slight tendency for an advanced dental maturation as compared with those with a skeletal deep bite.

Address for correspondence

Dr Guilherme R. P. Janson
Faculdade de Odontologia de Bauru
University of São Paulo
Departamento de Ortodontia
Alameda Otavio Pinheiro Brisolla 9-75
Bauru, SP 17043-101
Brazil

Acknowledgements

The authors would like to acknowledge CNPQ (Brazilian National Research Foundation) for its support, Dr Eymar Sampaio Lopes, for the statistical analysis and Mr Bruce James Wilroy, for the English revision of the manuscript.

References

Baughan B, Demirjian A, Levesque G Y, Lapalme-Chaput L 1979 The pattern of facial growth before and during puberty, as shown by French-Canadian girls. Annals of Human Biology 6: 59–76

Brown T, Barrett M J, Grave, K C 1971 Facial growth and skeletal maturation at adolescence. Tandlægebladet 75: 1211–1222

Chertkow S 1980 Tooth mineralization as an indicator of the pubertal growth spurt. American Journal of Orthodontics 77: 79–91

Coutinho S, Buschang P H, Miranda F 1993 Mandibular canine calcification stages and skeletal maturity. American Journal of Orthodontics and Dentofacial Orthopedics 104: 262–268

Demirjian A 1978 Dentition. In: Falkner F, Tanner J M (eds) Human growth, vol. 2. Plenum Publishers, New York, pp. 413–444

Demirjian A, Goldstein H, Tanner, J M 1973 A new system of dental age assessment. Human Biology 45: 211–227

Demirjian A, Buschang P H, Tanguay R, Patterson D K 1985 Interrelationships among measures of somatic, skeletal, dental, and sexual maturity. American Journal of Orthodontics 88: 433–438

Demish A, Wartmann P 1956 Calcification of the mandibular third molar and its relation to skeletal and chronological age in children. Child Development 27: 459–473

Engström C, Engström H, Sagne S 1983 Lower third molar development in relation to skeletal maturity and chronologic age. Angle Orthodontist 53: 97–106

Eveleth P B 1966 Eruption of permanent dentition and menarche of American children living in the tropics. Human Biology 38: 60–70

Fishman L S 1982 Radiographic evaluation of skeletal maturation. Angle Orthodontist 52: 88–112

Garn S M, Lewis A B, Polacheck D L 1960 Sibling similarities in dental development. Journal of Dental Research 39: 170–175

Garn S M, Lewis A B, Bonne B 1962 Third molar formation and its developmental course. Angle Orthodontist 44: 270–276

Garn S M, Lewis A B, Kerewsky R S 1965 Genetic, nutritional, and maturational correlates of dental development. Journal of Dental Research 44: 228–243

Gleiser I, Hunt E E 1955 The permanent mandibular first molar: its calcification, eruption and decay. American Journal of Physical Anthropology 13: 253–283

Grave K C 1973 Timing of facial growth: a study of relations with stature and ossification in the hand around puberty. Australian Orthodontic Journal 3: 117–122

Green L J 1961 Interrelationship among height, weight and chronological dental and skeletal age. Angle Orthodontist 31: 189–193

Gustafson G, Koch G 1974 Age estimation up to 16 years of age based on dental development. Odontologisk Revy 25: 297–306

Hägg U, Taranger J 1982 Maturation indicators and the pubertal growth spurt. American Journal of Orthodontics 82: 299–309

Johnston L E Jr 1975 A simplified approach to prediction. American Journal of Orthodontics 67: 253–257

Lamons F F, Gray S W 1958 Study of the relationship between tooth eruption age, skeletal development age, and chronological age in sixty-one Atlanta children. American Journal of Orthodontics 44: 687–691

Lewis A B, Roche A F, Wagner B 1985 Pubertal spurts in cranial base and mandible: comparisons within individuals. Angle Orthodontist 55: 17–30

Mappes M S, Harris E F, Behrents R G 1992 Regional differences in tooth and bone development. American Journal of Orthodontics and Dentofacial Orthopedics 101: 145–151

Marks R G 1985 Design of research projects. The basics of biomedical research methodology. Van Nostrand Reinhold Company, New York

Mitani H 1977 Occlusal and craniofacial growth changes during puberty. American Journal of Orthodontics 72: 76–84

Nanda S K 1988 Patterns of vertical growth in the face. American Journal of Orthodontics and Dentofacial Orthopedics 93: 103–116

Nanda S K, Rowe T K 1989 Circumpubertal growth spurt related to vertical dysplasia. Angle Orthodontist 59: 113–122

Niswander J D 1963 Effects of heredity and environment on development of the dentition. Journal of Dental Research 42: 1288–1296

Schulhof R J 1978 Die Computerwachstumsvorhersage: eine Hilfe für den Kieferorthopäden. Fortschritte der Kieferorthopädie 39: 363–375

Shuttleworth F K 1939 The physical and mental growth of girls and boys age six to nineteen in relation to age at maximum growth. Monograph of the Society for Research and Child Development 4: 1–291

Sierra A M 1987 Assessment of dental and skeletal maturity. A new approach. Angle Orthodontist 57: 194–298

Tanner J M 1962 Growth at adolescence, 2nd edn. Blackwell Scientific, Oxford

Thompson G W, Popovich F 1973 Relationship of craniofacial changes and skeletal age increments in females. Human Biology 45: 595–603