Incisor-molar Relations Of The Maxilla

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This investigation was made in order to clarify the anteroposterior relation between the permanent upper central incisor and the permanent upper first molar at different age levels during the eruptive period of development, from three years of age until the occlusal stage is reached. In the same period of age the vertical positions of the aforementioned teeth were studied. The purpose of this was to find general developmental tendencies of downward growth through the upper jaw.

Orban,[1] Brodie,[2,3] Carlson[4] and Diamond[5,6] agree that the permanent teeth do not migrate occlusally until root formation has begun. Carlson also states that the increase in rate of eruption takes place long before clinical emergence of the crown, and that emergence apparently does not decrease or increase the rate of eruption. Hurme[7] finds no sex difference in the range of variation in tooth eruption, although girls erupt their teeth on an average of five months earlier than boys. Shumaker and Hadary[8] found that all teeth begin to move toward the occlusal plane as soon as the crowns are completed. The average time between the stage of crown completion to the stage of occlusion was five years. Orban made the conclusion that the Hertwig's epithelial sheath remains at a fairly constant position while the growth of the tooth takes place. The investigation of Bradley[9] indicates that the canines and the premolars begin erupting when their crowns are complete, and these teeth reach the occlusal plane just before completion of their roots.

MATERIAL

The present material consists of 129 cephalometric profile roentgenograms of males ranging from 3 to 8 years of age. Most of the headplates represent children of kindergarten age. The age distribution of the whole sample appears in Table I. The three-year group comprises individuals having passed the age of three, but not the age of four and so on.

METHOD

The profile roentgenograms were obtained by using the head holder described by Björk. The focus-median plane distance was kept at 180 centimeters and the median plane-film distance at 10 centimeters. The meas-

Table I. Linear measurements in millimeters

Age	Number of cases	1-6		6-OL		1-OL		3-OL		Maxillary base length		N-S	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
3	12	35.8	1.6	9.4	1.4	11.3	1.2	14.7	1.7	42.5	2.2	60.5	2.8
4	25	36.1	1.2	8.9	1.9	11.2	2.0	15.7	1.7	44.1	1.8	62.8	2.4
5	34	36.8	1.9	6.5	2.4	10.7	1.7	16.5	1.5	45.3	2.1	64.8	2.2
6	26	39.0	2.1	3.2	3.4	6.1	3.9	15.6	1.2	46.6	2.0	65.8	2.1
7	15	43.6	2.8	0.1	0.2	1.1	2.1	15.1	1.4	47.8	2.7	67.1	3.1
8	17	42.6	2.2	0.0	0.0	0.0	0.0	14.1	2.1	47.5	2.3	66.8	2.6

urements are submitted without correction of magnification which is calculated at about 5.6 per cent in the median plane.

Cross-sectional growth studies involve several problems limiting their application. It is possible to acquire an understanding of the central growth tendency on the basis of the mean values at different age levels, but this tendency can only be approximated. The first reason is that the *standard error of the mean* is large when the number of individuals in each group is small. Secondly, the study comprises individuals in various age groups, who may differ biologically in many respects. Thus the group mean values are attended with *systematic errors,* which may not be included in the standard errors. The third reason is that each age group holds individuals with one year *dispersion of age,* which also may influence the group mean values.

Registration

All measurements in this study were linear measurements except the registration of the angle of maxillary prognathism. This angle is formed by the nasion-sella line representing the anterior cranial base and the profile line from nasion to subspinale; it was found to be of value as a control of the variability of the morphological patterns of this material. The linear measurements are of two different types, those between points lying in the midsagittal plane and those lying outside the midsagittal plane.

Since the main interest was to analyze the space occupied by the central incisor and the first molar and their interstitial dental structures, effort was made to find an anteroposterior measurement which would give a true picture of the actual space occupied and at the same time meet the requirements of precision in registration and exactness in method. Realizing that the tooth buds on their paths through the jaw are constantly changing their axial inclination and their general orientation within the jaw complex, it would not be an appropriate method to register distances between dental anatomical landmarks. It was found more adequate for the purpose of this study to apply the greatest length between distant contours of the two teeth. Thus all incisor-molar measurements are maximal anteroposterior distances registered between structures on the teeth at any given time (Fig. 1). This registration method is found to be the most satisfactory procedure available on which a comparative study of interdental relations may be based during eruptive stages of development.

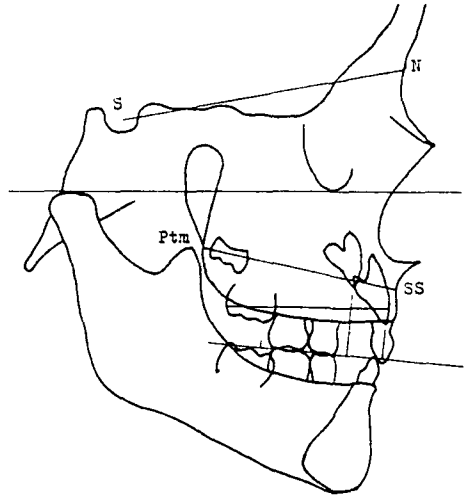

Fig. 1 Measurements made from lateral cephalometric x-ray films. The lines drawn perpendicular to the occlusal line represent eruptive positions of the permanent maxillary central incisor, the permanent maxillary canine and the permanent maxillary first molar. The incisor-molar space is registered as the maximal anteroposterior measurement between the labial contour of the permanent maxillary central incisor and the distal contour of the permanent maxillary first molar.

Measurements

(a) 1-6: The maximal anteroposterior distance between midsagittal projections of the labial surface of the permanent upper central incisor and the distal surface of the permanent upper first molar.

(b) 6-OL: The perpendicular distance between the midsagittal projection of the mesiobuccal cusp tip of the permanent upper first molar and the occlusal line OL.

(c) 1-OL: The perpendicular distance between the midsagittal projection of the incisal edge of the permanent upper central incisor and the occlusal line OL.

(d) 3-OL: The perpendicular distance between the midsagittal projection of the cusp tip of the permanent upper canine and the occlusal line OL.

(e) Maxillary base length: The distance between subspinale (SS) and the midsagittal projection of the posterior surface of the maxillary tuberosity.

(f) N-S: The external length of the anterior cranial base measured from nasion to the center of sella turcica.

The occlusal line, OL, was constructed as the connecting line between the cusp tips of the deciduous molars, and the line was extended in anterior and posterior directions.

Anteroposterior Development

The material was tested for variation of cranial morphology. The average length of the nasion-sella distance was calculated at each age group and the mean value was found to increase gradually from 60.5 mm at 3 years of age to 67.1 mm at the age of 7. The means and the standard deviations of the different measurements appear in Table I. There was no increase of the average N-S distance from the age of 7 to the age of 8 years. This is probably due to the low number of individuals in the last two sample groups which cause the standard error of the mean to be large.

Furthermore, the variability of the individual prognathism of the upper jaw was analyzed. The maxillary prognathism was expressed by the angle S-N-SS. The results indicate that the mean values of this angle calculated at each age group differ by only 2 degrees. The probability, that differences between group mean values of the angle S-N-SS are due to chance, is more than 0.2. As far as prognathism is concerned the material appears to reflect the homogenous morphologic pattern on which an investigation of the different components of the upper jaw may be based.

The length of the maxillary base was measured from subspinale (SS) to the posterior surface of the maxillary tuberosity at the level of the most posterior tooth in the jaw. The average anteroposterior length of the upper jaw was found to increase 5.3 mm from 3 years of age to the age of 7.

From Table I it may be seen that the incisor-molar space, 1-6, increases by 7.8 mm on the average from 3 years of age to 7. The average increase of the incisor- molar space from the 6 year level to the 7 year level was 4.6 mm. This great change in position takes place just before arrival in the occlusal plane.

Vertical Development

The average position of the upper first molar at the beginning of this

Table II. Correlations of dental and skeletal measurements

Correlations	r	b x	b y
N-S and maxillary base length	+0.72	+0.61	+0.85
6-OL and 1-6	—0.69	—0.58	—0.83
6-OL and 1-OL	+0.78	+0.94	+0.64
N-S and 1-6	+0.60	+0.66	+0.55
1-OL and 1-6	—0.79	—0.55	—1.15
Maxillary base length and 1-6	+0.73	+0.94	+0.56

r = the product moment correlation coefficient b = the regression coefficients

growth period was 9.4 mm above the occlusal plane. The average downward growth is slow from the age of 3 to the age of 4 years after which eruption continues at an increased rate. At the 8 year level all the upper first molars had descended to the occlusal plane.

The average position of the upper central incisor at the 3 year level was calculated to be 11.3 mm above the occlusal plane. Similar to the upper first molar the average downward growth of the upper central incisor is rather slow at the beginning of the growth period, but at the 5, 6, and 7 year levels eruption goes on at an increased rate. In the 8 year group all central incisors had arrived at the occlusal plane.

The average distance from the upper canine to the occlusal plane at 3 years of age was calculated to be 14.7 mm. The mean values indicate that this distance increases to 16.5 mm at 5 years of age after which the tooth goes into a descending movement. At 8 years of age the average distance from the canine to the occlusal plane was found to be 14.1 mm which is less than the initial mean at the 3 year level.

Correlations

The problem of primary interest in this paper is the degree of coordination between eruption and the anteroposterior development of the incisor-molar space. This space is of great importance to the alignment of teeth in the future dentition, and because an expanding development of the incisor-molar space takes place within the maxilla, the further procedure necessarily calls for a closer study of how the incisor-molar space is related to the maxillary base and the anterior cranial base. Table II demonstrates how the different measurements are related to each other. The product moment correlation coefficients, "r," of the different coordinated dimensions are calculated, and the correlative estimates indicate the general tendency to coordination in individual development.

The most intimate correlation is found between 1-OL and 1-6. The two measurements change *inversely* and the correlation coefficient is calculated to —0.79. The figures denote that the incisor-molar space is more intimately related to the descending movement of the central incisor than to the descending movement of the first molar, the former correlative estimate being —0.79 and the latter—0.69. There is a clear evidence of coordination between the anterior cranial base, N-S, and the maxillary base length, the correlation coefficient being +0.72. The corresponding figure calculated between the maxillary base length and 1-6 is found to be +0.73. The correlative estimate of the anterior cranial base length, N-S,

and the incisor-molar space is calculated to only +0.60. The coefficients of regression of the correlated variables appear in the last two columns of Table II.

Discussion

In clinical orthodontics the occlusal plane is literally the platform to which vertical tooth position is related. From a functional point of view the ideal goal of every dental unit in eruption is the working position, i.e., when contact is established between the tooth and its antagonists. In the present analysis the teeth involved are related to this final occlusal stage. When studying tooth eruption different growth phenomena must be taken into consideration. The eruption of teeth is accompanied by resorption and regeneration of the alveolar process. Because of this constant change the alveolar process would fail to serve as a stable reference of downward migration of the teeth. The conclusion made by some investigators, that the occlusal displacement of teeth takes place by the formation of new bone around the apex, does not make basal structures of the maxilla more reliable for the purpose of reference. Not even the nasal floor, referred to as the nasal line in lateral profile x-rays, remains stable in the growth period here studied.[10] When studying dental casts the occlusal plane is the only plane of reference unless gnathostatic casts are employed. Wylie[11] says that "the reason why the occlusal plane is not being accorded a position of significance in cephalometrics is that it is subject to our ministrations during treatment."

Concerning the anteroposterior migration of the teeth during eruption the knowledge gained from this analysis is limited to the relative movements of the central incisor and the first molar. We must be satisfied to find that the incisor-molar space is more intimately related to the eruption of the central incisor than to the eruption of the first molar.

On the average the increase of the incisor-molar space from 3 years of age to the age of 7 was calculated as 7.8 mm. The average anteroposterior growth of the maxilla in the same developmental period was 5.3 mm. At the beginning of the growth period the average growth of the upper jaw exceeds the increase of the incisor-molar space, but towards the end of the same period the maxillary growth is insufficient to compensate for the rapidly increasing distance between these two teeth. However, the correlation coefficient +0.73 indicates that the incisor-molar space generally is intimately coordinated to the anteroposterior maxillary base length in individual cases. Further investigation ought to be carried out upon the transverse migration of these teeth during the same eruptive stages of development.

Summary

1. Cross-sectional study of 129 profile roentgenograms shows that the anteroposterior space between the labial surface of the permanent upper central incisor and the distal surface of the permanent upper first molar increases by 7.8 mm on the average from 3 years of age to the age of 7.

2. The average distance of the permanent upper central incisor measured from the incisal edge to the occlusal plane at 3 years of age is calculated as 11.3 mm.

3. The average distance of the permanent upper first molar measured from the mesiobuccal cusp to the occlusal plane is found to be 9.4 mm at 3 years of age.

4. The position of the permanent upper canine does not change significantly on the average from the age of 3 years to 8 years of age.

5. The average anteroposterior enlarge-

ment of the maxillary base length from 3 years to 7 years of age is 5.3 mm.

6. The anteroposterior incisor-molar space is intimately coordinated to the downward eruption of the central incisor.

Conclusion

Development of the maxillary jaw from 3 years of age to the age of 7 is accompanied by enlargement of the incisor-molar space. The enlargement is primarily due to the anterior migration of the central incisor during its downward eruption through the upper jaw.

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