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Palatometry : suggested norms for clinical surveys

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PALATOMETRY: SUGGESTED NORMS FOR CLINICAL SURVEYS

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Synopsis

A random sample of 176 children of grade school age were selected in an attempt to obtain norms for palatal height. The data was processed by the use of biostatistical techniques. Calculations of the mean, standard error, and standard error of the mean for each individual age group was established.

A modification of the Gorlin Palatometer was constructed for this purpose, with emphasis on an instrument that could be easily used in rapid clinical surveys and still provide statistical reliability.

It is hoped that this data will help to eliminate subjective bias and enable more quantitative appraisals to be made of this physical finding commonly seen in various musculoskeletal deformities, congenital anomalies, and numerous genetical disorders.

Introduction

Recent attention has been focused upon the frequent finding of high arched palates in certain apparently unrelated diseases. Such conditions include Apert syndrome, Morquio syndrome, Bonnevie-Ullrich-Turner syndrome, Franceschetti Treacher Collins syndrome, Freeman-Sheldon syndrome, Marfans syndrome, Neilson syndrome, pseudo-crouzan syndrome, Rossi syndrome, and cleidocranial dysostosis.[5] The congenital defect studies of Smith and Bastian[17] reveal cleft lip and palate abnormalities associated with ventral septal defects and mental retardation. Lynch et al emphasized the frequent observation of high arched palates in family members suspected of having hereditary ataxias.[13]

However the palatal vault, unless grossly abnormal, frequently receives little attention in the course of routine physical examinations. The methods of clinically establishing a physical measurement, for the most part, have been left to emperical judgment.

Literature Review

It is of historical interest to note that as early as 1830, controversial studies of the dental arch existed (Thomas Bell),[1] and as far back as 1771 John Hunter stressed the need for longitudinal data of jaw growth.

Other investigative pioneers directed their efforts toward further establishing a framework for the art of orthodontics. Consequently, subsequent research emphasized the dental arch and arch circumference in an attempt to relate developmental changes with various aspects of dentition.

Huter in 1864 was perhaps one of the first to publicize measurements of skeletal specimens with the conclusion that the dental arch containing the molar teeth grow four times more than that which contains the incisors and canine teeth.[10]

Carl Wedl in 1870 used a moistened paper strip to determine the dental arch circumference on skulls of 45 children, noting size relations between the periods of deciduous and permanent dentition.[14]

Otto Zsigmondy in 1890 took dental casts of 3 children at regular intervals during the transitional period of their dentition and provided an excellent discussion of the difficulties in studying developmental changes due to the migration of teeth.[20]

In 1908 when Channing and Wissler compared palate measurements of normal and feeble-minded individuals, they observed a great variety of palate shapes in the two groups studied.[3]

Perhaps one of the more classic studies by Brash in 1924 might be used to examplify an observation common to much of the research which was to follow. His conclusions suggested that palate deformities were not to be sought in some comparatively late point of the growth period, "for the interference with growth is concealed in happenings that are very early indeed".[2]

Further investigations made in an attempt to pattern growth phases and arch development often resulted in considerable diversity. Much of this can be attributed to variations in procedure, biometrical technique, and types of material used as well as choice of landmarks in the oral cavity. However, some of the important contributions may be observed in the following paragraphs.

Hamano (1929) studied children in Japanese elementary schools noting the change in maxillary arch breadth. According to his tabular data, the mean changed very little between the ages of 5 and 10 years, but was accelerated during the emergence of the maxillary and mandibular incisors.[6] The studies of Lewis and Lehman in 1929 of 170 elementary school children observed the greatest mean increase in the breadth of the dental arch to occur between the ages of 6 and 8½ years of age. However, a marked variation in all features studied was stressed by the authors.[12]

Harth (1930) reported the distances between the deciduous second molars in the maxilla for the age groups of 6-8, 12-14, and 16-18. As would be expected, the variations in arch breadth was quite large, but the repeated notation of an increase in palatal height, especially in the permanent first molar area was observed.[7]

The contributions of Clinch in 1951 revealed the arch breadth in the canine region showed small increases before the time of emergence of the permanent incisors. During the eruption of these teeth the increase was accelerated, and it continued thereafter, but to a reduced extent. These conclusions were determined after a 5 year study of dental casts at yearly intervals.[4]

O'Reilly in 1951 made an analysis of 130 children with examinations four times a year. He noted the average breadth was greater in boys than in girls, however the mean increase in intercanine distance was 20 percent greater in girls between the ages of 5 and 7 than in boys. This growth variation exemplifies still another palatometric variable.[15]

Henriques (1953) in a cross sectional study of palate and face growth, using a sample of 600 7 to 12 year old children, found that in general a progressive increase in palate breadth was observed with age. It was also noted that the length of the dental arch remained unchanged once the permanent maxillary first molars had emerged. These metrical observations were obtained directly in the oral cavity at seven different points.[8]

In 1962, Lebret was able to demonstrate growth changes in palatal height and breadth with a technique involving superimposed serial tracings.[12] Using the symmetrograph of Korkhaus[17] and serial dental casts of children of ages 5 through 13, he revealed that the alveolar processes increase in height and breadth continuously while the top of the palate vault remained essentially constant except for slight increments in breadth at the apex. (Fig. I)

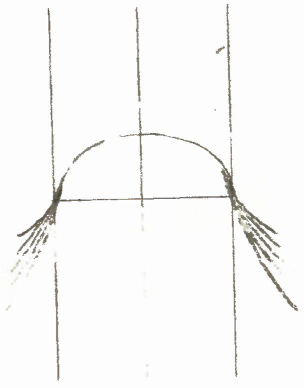

Fig. I
Lebret's superimposed serial tracings demonstrating absence of growth changes at the apex of the vault.

This lateral growth of the maxillae is coordinated with the growth of permanent teeth, while growth of the alveolar process is ultimately dependent upon tooth eruption.[19] In essence, Lebret thereby demonstrated that an increase in total palatal height ultimately resulted from lengthening of the maxillae. This data prompted an interest of width dimention which was included in the present survey.

Material

The present study employs a type of bidimensional caliper which enables one to establish measurements in mm. of palatal width as well as palatal height.

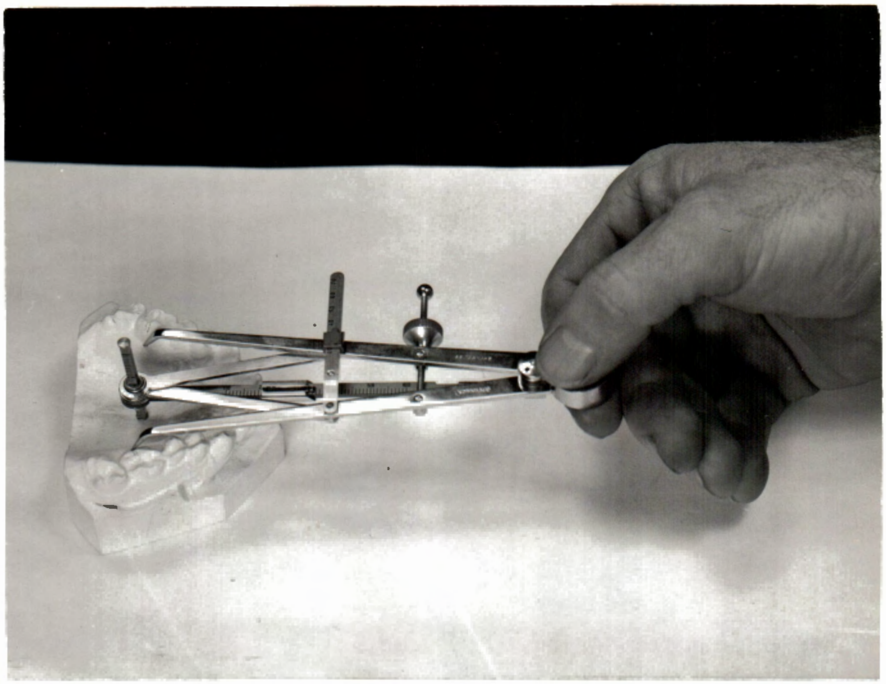

Fig. II
Application of palatometer to dental cast demonstrating technique of obtaining palatal dimensions.

This instrument is a modification of the Gorlin Palatometer[5] which was somewhat similar, except for the determination of height which Gorlin obtained from the area of the fovea palatinus. The decision for a modification was based on two observations. First, the fovea palatinus is not necessarily the highest dimension of the vault. Second, the correlation of growth rate of the maxilla with dentition and relative increases in palatal height necessitates obtaining both parameters in the same plane.

Technique

This particular technique employed measurements taken directly from the oral cavity without the need for dental casts. A horizontal plane was established by electing to use the junction of the lingual cervicle line and the developmental groove of the maxillary first molars. Palatal width was then defined as the distance between these two antimers. A calibrated perpendicular from this transverses plane to the raphe determined palatal height. The interdental papilla between the two maxillary incisors served as a stabilizing third point. (Fig. II)

Source of Data

The data for this study was derived by obtaining a random sample of 176 grade school children belonging to Omaha's middle socio-economic class. All of the subjects studied were without abnormalities, and had no history of chronic disease. The ages were approximately equal in distribution from 6 to 13, and included 85 females and 91 males. After all the data had been compiled, it was biostatistically processed for determinations of the mean, standard error, and standard error of the means. The range for each parameter was also included.

Discussion and Analysis of the Data

In Gorlin's studies a palatal index was stressed $\left(\frac{\text{Height}}{\text{Width}} \times 100\right)$ in an attempt to arrive at a single numerical expression which could be compared with conditions associated with altered palatal height.[5] This formula has been applied in the present study, however it was observed that either the width or height may vary beyond the two standard deviation limit without necessarily resulting in an abnormal index (Table I).

The calculated results are presented in tabular and graphic form. Each graph shows a mean value and range of the feature studied as well as curves for the two standard deviation limit. From these curves the patterns of variation between the ages of 6 and 13 can be approximated. It was realized that the use of chromological age yields more variation in the results than would be expected from using bone age. However, it was less feasible to base the analysis on bone age, since one of the objectives of this study was to determine the possible use of such an instrument in rapid clinical surveys.

A group of 5 year old children who had not yet acquired the first molar were also included in the study. This was done for comparative purposes in an attempt to determine the amount of correlation with Lebret's data. The landmark employed in this age group was the second bicuspid; the remainder of the technique was unchanged. It was observed that the mean width of Lebret's sample of 5 year olds was 29.57 mm. with a range of 25.5 to 34.0 mm.[12] The mean width in this study of the same age group was 29 mm. with a range of 26 to 35 mm. Lebret's mean height was 10.5 mm. with a range of 7.0 to 13.0 mm. compared with the present data mean of 12.5 mm. with a range of 11.5 to 14.0 mm. The difference of a 2 mm. mean in the latter parameter could well be attributed to the fact that Lebret used the most dorsal aspect of the distal surfaces of the two second molars, whereas the construction of the present instrument precluded the use of this anatomical point because of a stability factor. Hence it was necessary to use a more mesial point along the lingual border. Consequently, the data in reference to 5 year olds is included separately because of the difference in landmarks. No further comparison could be made, for Lebret's subsequent measurements were taken from the ruga relative to the original dental cast.

In the 176 subjects studied, 13 measurements were noted to be beyond two standard deviations. Of these 13, only 6 demonstrated a significant change in palatal index.

The period of greatest change in width was noted in the ages 9 through 13, while the most significant increase in height occurred in the 7 to 10 age group. A greater overall increase in width resulted in a progressive decrease in the mathematically formulated palatal index in each respective age group.

As would be expected, a considerable range exists in both height and width in all age groups.

Summary and Conclusions

References to high arched palates associated with musculoskeletal disorders have frequently been cited in the literature. Early attempts to determine growth rate and palate dimensions were met with difficulty due to the migration of teeth, variations in procedures and the lack of normal values. As a result, this physical finding has been left to emperical judgment and subjective bias.

This paper proposes the use of a bidimentional caliper which negates the use of dental casts and yet provides statistical reliability in clinical surveys.

A random sample of 176 children was used to establish norms for the ages of 6 through 13. All calculations were biostatistically processed. Means for palatal width, palatal height and palatal index were established.

It is noteworthy to mention that increments in palatal height are the results of growth changes of the maxilla; and the most dynamic periods of growth are related to the ages of deciduous and permanent dentition.

The range of variation in mean palatal width of these age groups studied was from 29 to 37 mm. The range of mean height was from 12.5 to 14.0 mm. Palatal index $\left(\frac{\text{Height}}{\text{Width}} \times 100\right)$ was observed to decrease with age. This latter finding demonstrates the growth phenomena of the alveolar processes increasing in height and width while the top of the palatal vault remains constant.

Another interesting observation was that statistically significant variations could occur in any one of these three dimensions without necessarily affecting the other two.

It is proposed that these norms be applied to patients with the above mentioned syndromes in order to establish values for quantitative comparison. This instrument might thereby provide usefulness in a variety of clinical surveys and stimulate investigations of this fascinating aspect of human biology.

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PALATE MEASUREMENTS

TABLE I

AGE	SEX	WIDTH (in MM)	INDEX (in MM)	HEIGHT (in MM)
5	M	30	40	12.0
5	M	30	42	12.5
5	M	33	41	13.5
5	M	29	45	13.0
5	F	26	40	10.5
5	F	26	52	13.5
5	F	27	51	14.0
5	M	35	37	13.0
5	M	27	44	12.0
5	F	28	45	12.5
5	F	30	40	12.0
5	F	28	41	11.5
5	M	27	48	13.0
5	F	28	46	13.0
5	M	29	43	12.0

AGE	SEX	WIDTH (in MM)	INDEX (in MM)	HEIGHT (in MM)
6	M	31	47	14.5
6	M	27	48	13.0
6	M	27	39	10.5
6	M	30	37	11.0
6	M	27	48	13.0
6	M	29	44	13.5
6	F	28	41	11.5
6	F	28	50	14.0
6	F	30	35	10.5
6	M	27	50	13.5
6	F	29	43	12.5
6	F	24	54	13.0
6	F	27	44	12.0
6	F	35*	37	13.0
6	F	28	41	11.5
6	F	29	43	12.5
6	F	26	37	9.5*
6	F	28	41	11.5
7	M	31	37	11.5
7	M	29	39	11.5
7	M	31	40	12.5
7	M	30	48	14.5

AGE	SEX	WIDTH (in MM)	INDEX (in MM)	HEIGHT (in MM)
7	M	30	40	12.0
7	M	25	40	10.0
7	M	26	48	12.5
7	F	30	42	12.5
7	M	34*	38	13.0
7	M	28	41	11.5
7	M	31	43	13.5
7	M	30	33	11.0
7	F	30	47	14.0
7	F	28	48	13.5
7	F	29	41	12.0
7	F	24*	52*	12.5
8	F	33	35	11.5
8	M	27	50	13.5
8	M	33	39	13.0
8	F	29	41	12.0
8	F	30	38	11.5
8	F	33	39	12.0
8	F	28	55	15.5
8	F	28	52	14.5
8	M	31	40	12.5
8	F	30	41	12.5

AGE	SEX	WIDTH (in MM)	INDEX (in MM)	HEIGHT (in MM)
8	M	34	49	16.5*
8	F	32	42	13.5
8	M	33	38	12.5
8	M	21*	69*	14.5
8	M	26	43	11.5
8	F	27	46	12.5
8	F	24	52	12.5
8	F	29	50	14.5
8	M	33	32	10.5
8	M	30	40	12.0
8	M	31	42	13.0
8	M	34	37	12.5
8	M	26	52	13.5
8	M	27	56	15.0
8	M	27	46	12.0
9	M	32	55	17.5*
9	M	31	43	13.5
9	F	41*	34	14.0
9	F	31	47	14.5
9	M	30	40	12.0
9	M	31	38	12.0
9	F	28	41	11.5
9	M	30	45	13.5

AGE	SEX	WIDTH (in MM)	INDEX (in MM)	HEIGHT (in MM)
9	M	29	48	14.0
9	M	30	58	17.5*
9	F	33	41	13.5
9	F	24*	56	13.5
9	F	33	36	12.0
9	M	30	42	12.5
9	M	31	43	13.5
9	M	27	55	15.0
9	M	35	39	13.5
9	F	28	50	14.0
9	M	33	39	13.0
9	M	34	39	13.5
9	M	30	50	15.0
10	M	33	41	13.5
10	M	34	46	15.5
10	M	34	39	13.5
10	F	29	45	13.0
10	F	29	55	16.0
10	F	29	43	12.5
10	M	30	53	16.0
10	M	32	42	13.5
10	M	30	52	15.5
10	F	31	35	11.0

AGE	SEX	WIDTH (in MM)	INDEX (in MM)	HEIGHT (in MM)
10	F	36	40	14.5
10	M	35	43	15.0
10	M	27	54	14.5
10	F	33	35	11.5
10	F	30	40	12.0
10	F	33	35	11.5
10	F	33	39	13.0
10	F	23*	67*	15.5
10	F	29	43	12.5
10	M	35	41	14.5
10	F	27	50	13.5
10	F	31	43	13.5
10	M	30	43	13.0
10	M	28	50	14.0
10	M	28	51	14.0
11	M	30	41	12.5
11	F	30	63*	19.0*
11	M	33	42	14.0
11	F	33	48	16.0
11	F	26*	56*	14.5
11	M	36	38	13.5
11	M	39	37	14.5

AGE	SEX	WIDTH (in MM)	INDEX (in MM)	HEIGHT (in MM)
11	M	32	39	12.5
11	M	33	41	13.5
11	F	34	35	13.0
11	M	37	36	14.0
11	F	34	29	10.0
11	F	32	36	11.5
11	F	30	42	12.5
11	F	33	38	12.5
11	M	33	41	13.5
11	M	39	36	14.0
11	F	30	42	12.5
11	M	34	31	10.5
11	M	38	34	13.0
11	F	34	39	13.5
12	F	30*	48*	14.5
12	M	34	43	14.5
12	M	40	24	10.5
12	M	40	27	11.0
12	M	39	36	14.0
12	F	40	28	14.0
12	F	36	39	14.0
12	F	39	32	12.5
12	F	38	36	13.5

AGE	SEX	WIDTH (in MM)	INDEX (in MM)	HEIGHT (in MM)
12	M	38	38	14.5
12	F	37	43	16.0
12	F	33	39	13.0
12	F	36	33	12.0
12	M	35	38	12.0
12	F	34	38	14.0
12	M	38	28	10.5
13	M	30	48	14.5
13	M	34	41	14.0
13	M	40	29*	11.5
13	F	36	32	11.5
13	M	34	43	14.5
13	F	33	47	15.5
13	F	34	43	14.5
13	F	33	45	15.0
13	F	33	39	13.0
13	M	35	37	13.0
13	M	33	39	13.0
13	F	33	41	13.5
13	M	40	34	13.5
13	F	38	36	13.5
13	M	35	43	15.0

AGE	SEX	WIDTH (in MM)	INDEX (in MM)	HEIGHT (in MM)
13	F	36	44	16.0
13	F	35	34	12.0
13	F	35	41	14.5
13	F	38	45	17.0

*Asterisk denotes individual measurements which were greater than two standard deviations from their respective means and thereby statistically significant.

AGE	NO. OF SAMPLES	MEAN	RANGE	S.D.	S.E.M.
6	18	28	24 - 35	±2.3	±0.54
7	16	29	26 - 34	±2.4	±0.60
8	25	29	21 - 34	±3.3	±0.66
9	21	31	24 - 41	±3.3	±0.72
10	25	31	23 - 36	±3.0	±0.60
11	21	33	26 - 39	±3.2	±0.70
12	16	37	30 - 40	±2.8	±0.70
13	19	35	30 - 40	±2.5	±0.57

Table II

Summarized Data of Palate Width
All values are expressed in MM
S.D. = Standard Deviation
S.E.M. = Standard Error of the Means

AGE	NO. OF SAMPLES	MEAN	RANGE	S.D.	S.E.M.
5	15	29	26 - 35	± 2.4	± 0.62

AGE	NO. OF SAMPLES	MEAN (in MM)	RANGE (in MM)	S.D.	S.E.M.
6	18	12.5	9.5 - 14.5	±1.3	±0.33
7	16	12.5	10.0 - 14.0	±1.1	±0.28
8	25	13.0	10.5 - 16.5	±1.4	±0.28
9	21	14.0	11.5 - 17.5	±1.5	±0.33
10	25	13.5	11.0 - 15.5	±1.4	±0.28
11	21	13.5	10.5 - 19.0	±1.8	±0.39
12	16	13.0	10.5 - 16.0	±1.6	±0.40
13	19	14.0	11.5 - 17.0	±1.4	±0.32

Table III

Summarized Data of Palate Height

S.D. = Standard Deviation

S.E.M. = Standard Error of the Means

AGE	NO. OF SAMPLES	MEAN (in MM)	RANGE (in MM)	S.D.	S.E.M.
5	15	12.5	11.5 - 14.0	±0.9	±0.23

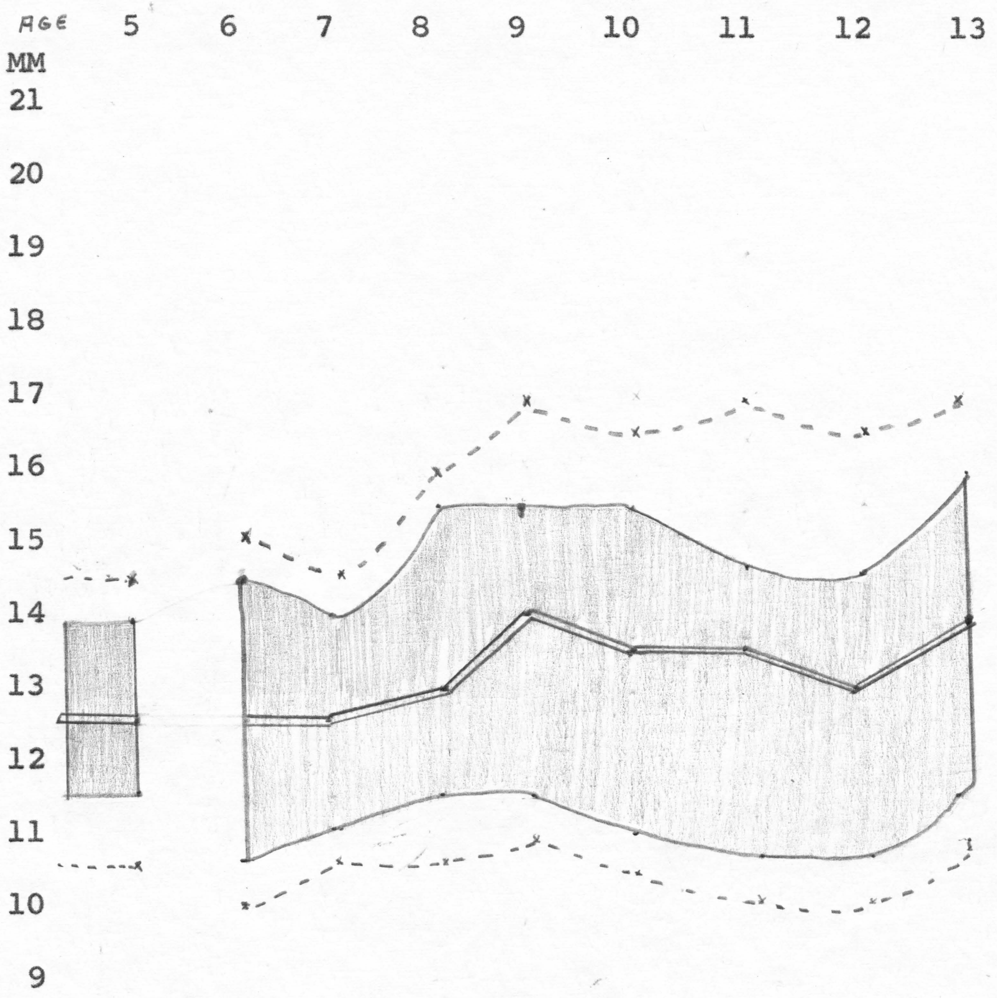
AGE	NO. OF SAMPLES	MEAN	RANGE	S.D.	S.E.M.
6	18	45	35 - 54	±6.0	±1.4
7	16	42	33 - 52	±4.9	±1.2
8	25	45	32 - 69	±6.7	±1.3
9	21	45	34 - 58	±6.5	±1.4
10	25	47	35 - 67	±7.6	±1.5
11	21	39	34 - 63	±7.6	±1.7
12	16	35	24 - 48	±6.4	±1.6
13	19	40	29 - 48	±5.1	±1.2

Table IV

Summarized Data of Palate Index ($\frac{H}{W}$ x 100)

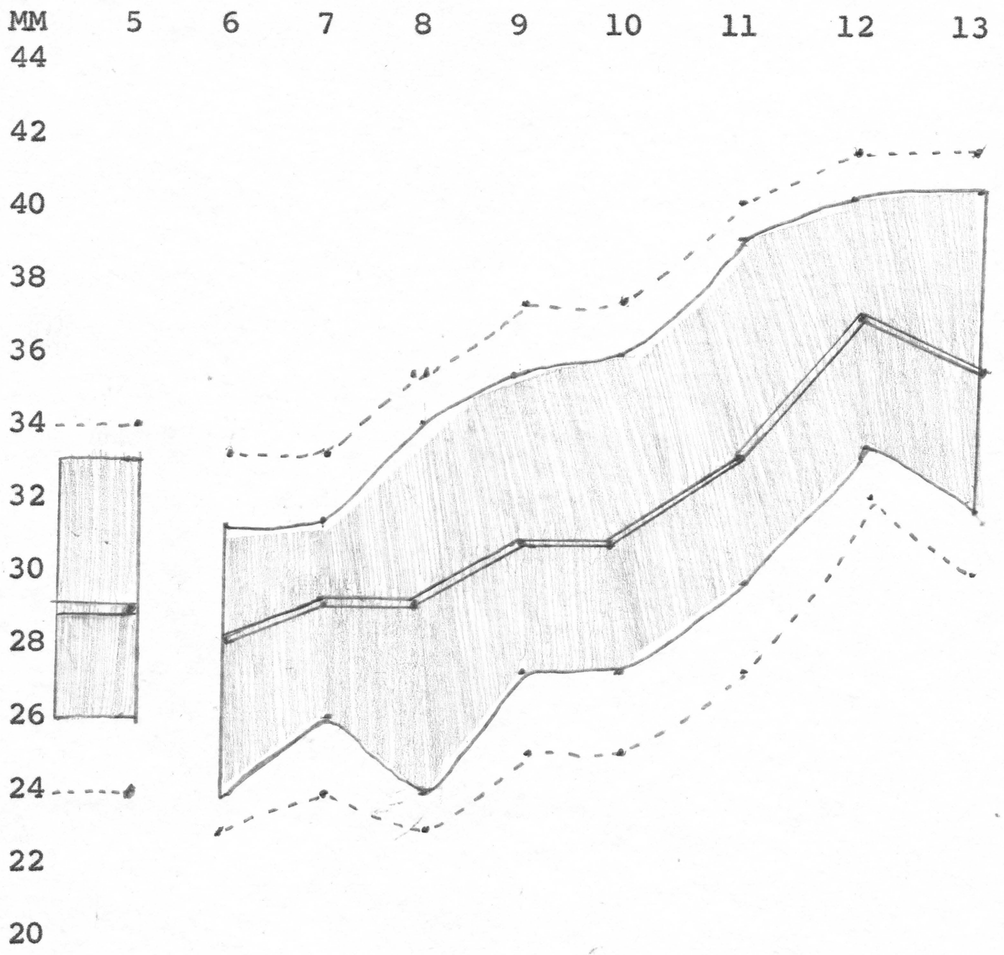
S.D. = Standard Deviation
S.E.M. = Standard Error of the Means

AGE	NO. OF SAMPLES	MEAN	RANGE	S.D.	S.E.M.
5	15	43	40 - 52	± 4.2	± 1.1



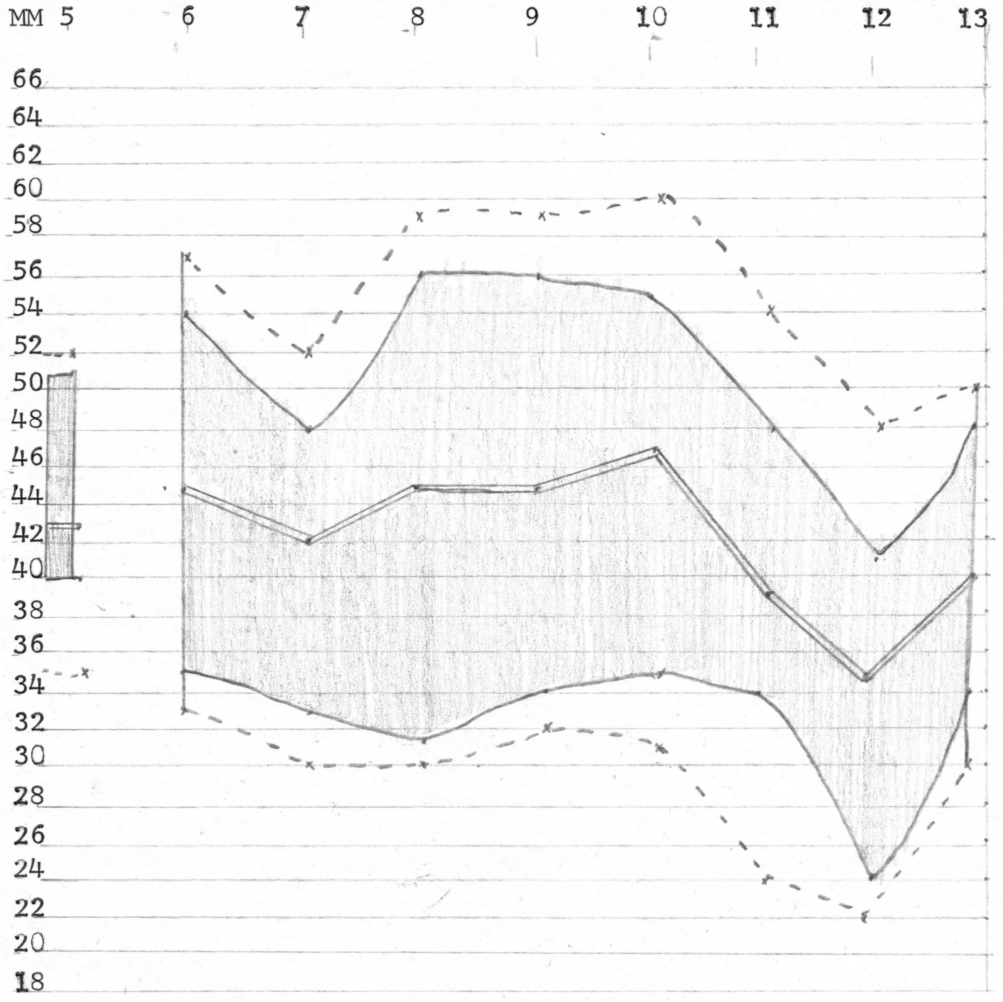
Graph II Palate Height Data

Double line represents the mean height
Shaded area represents the height range
Dotted line represents the statistically two standard deviation from the mean height



Graph I Palate Width Data

Double line represents the mean
Shaded area represents the range
Dotted line represents the statistically significant two standard deviation from the mean width



Graph III　　　　　　　　　Palate Index

Double line represents mean index
Shaded area represents the index range for each age group
Dotted line represents the statistically significant two
standard deviation from the mean index

APPENDIX IV

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