Longitudinal Study of Dental Arch Widths at Four Stages of Dentition

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Materials collected serially at the University of Iowa between 1946 and 1960 on facial, dental, and other aspects of human growth have supplied the basic data for numerous research reports. Among the dental studies from this source, five presented analyses on dental arch widths. Over the childhood period between ages 4 years and 8 years, widths at the deciduous canines were analyzed by Meredith and Hopp[6] and at the deciduous second molars by Holcomb and Meredith.[2] Widths at the permanent first molars were reported by Meredith and Cox[4] in children 9 years of age, and by Knott[3] at ages between 9 years and late adolescence. Relationships between dental arch widths and widths of the head and face were studied by Meredith and Higley.[5]

Between 1968 and 1971 a number of the subjects seen throughout childhood were re-examined in early adulthood (at ages ranging from 23 to 30 years).

For each subject maxillary and mandibular casts, made from alginate-base hydrocolloid impressions, were accumulated at semiannual intervals from age 4 years to age 12 years, at annual intervals during adolescence, and at one age in early adulthood. Thus it is now possible to report growth findings on the same individuals over a span of twenty years.

The present study gives results on three widths of each dental arch at four stages of dentition. Using the gingival level, the labiobuccal widths measured on each arch were:

1. Maximum rectilinear distance between the lateral incisors.

2. Maximum rectilinear distance between the canines.

3. Maximum rectilinear distance between the deciduous second molar teeth or second premolar teeth.

These measurements were made on maxillary and mandibular casts at four stages of dental development designated:

Stage D (Deciduous dentition). Always the casts used had been obtained no more than six months prior to the shedding of any deciduous tooth, or eruption of any permanent tooth. The majority of the casts were from children between ages 5 years and 6 years; the average age was 5.4 years.

Stage M (Mixed dentition). The casts used satisfied the following criteria: There were six permanent teeth (the incisors and first molars) and six deciduous teeth (canines and molars) present in each of the two arches. Most casts were from subjects at ages between 9 years and 10 years; the average age was 9.4 years.

Stage P (Permanent dentition). Casts were accepted for measurement at the earliest age when twenty-eight permanent teeth were all one year beyond gingival emergence, so that approximately 90 per cent or more of maximum eruption height had been obtained.[1] The average age for these casts was 13.6 years.

Stage YA (Young adult). Casts were used from subjects showing twenty-eight or more permanent teeth intact ten years after stage P. The age at this stage averaged 25.9 years.

By restricting the subjects for the present report to individuals who had received no orthodontic treatment, casts for twenty-one males and fourteen females were on file for the first three

TABLE I

Mean Dental Arch Widths (mm) on Longitudinal Data for Males and Females

Dental Stage	Mandibular Dental Arch: At Lateral Incisors	Mandibular Dental Arch: At Canines	Mandibular Dental Arch: At Second Molars or Premolars	Maxillary Dental Arch: At Lateral Incisors	Maxillary Dental Arch: At Canines	Maxillary Dental Arch: At Second Molars or Premolars
			Males			
D (Deciduous)	18.1*	28.5*	46.1*	23.6*	35.5*	49.7*
M (Mixed)	21.7	31.3*	47.5*	30.2	38.4*	51.7*
P (Permanent)	21.2	31.6	47.5	29.3	40.4	53.1
YA (Young Adult)	20.6	31.4	47.0	29.0	40.6	52.9
			Females			
D (Deciduous)	17.6*	27.0*	43.0*	23.2*	33.6*	46.6*
M (Mixed)	21.1	29.9*	44.6*	29.0	36.3*	48.3*
P (Permanent)	20.9	30.3	44.6	28.1	38.0	49.7
YA (Young Adult)	20.3	30.4	44.3	27.7	37.8	49.2

* Means of measurements on deciduous teeth.

stages. Of these, for fifteen males and eleven females there were casts made at the young adult stage. To increase sample size for studying change from stage P to stage YA, data were added from seven males and four females on whom casts at these two stages were available.

It follows that the statistics are from the same subjects at stages D, M, and P, while those beyond this are from a slightly different group. The mean changes computed for the fifteen males and eleven females between stages P and YA vary by no more than 0.1 mm from the mean changes computed on the larger group. Using the larger group (twenty-two males and fifteen females), however, yields a more reliable estimate of variance.

The subjects are healthy individuals from families above average in socioeconomic status, Caucasoid, and primarily of northwest European ancestry.

All dimensions were measured independently by two individuals and repeated when there were differences of 0.3 mm or more between the two initial measurements. The data analyzed were averages of these two or four measures.

Findings

Means obtained for the three widths of each dental arch, specific for sex, are listed in Table I and presented graphically in Figure 1.

It is seen:

1. The mean trend lines for the two sexes are essentially parallel.

2. Males yielded larger means than females, with magnitude of the difference increasing anteroposteriorly. In the mandibular arch, means on males exceed those on females by approximately 0.5 mm for width between the deciduous lateral incisors, by 1.0 to 1.5 mm for width between the canines, and by about 3.0 mm for width between the deciduous second molars or second premolars. In the maxillary arch corresponding differences are near 1.0, 2.5 and 3.0 mm. It was previously reported that, in the molar region, males had wider dental arches than females both in absolute size and relative to arch depth.[3] Here it is seen that the dental arch for males also is wider in the posterior region relative to the anterior region.

3. During the transition from completely erupted deciduous dentition

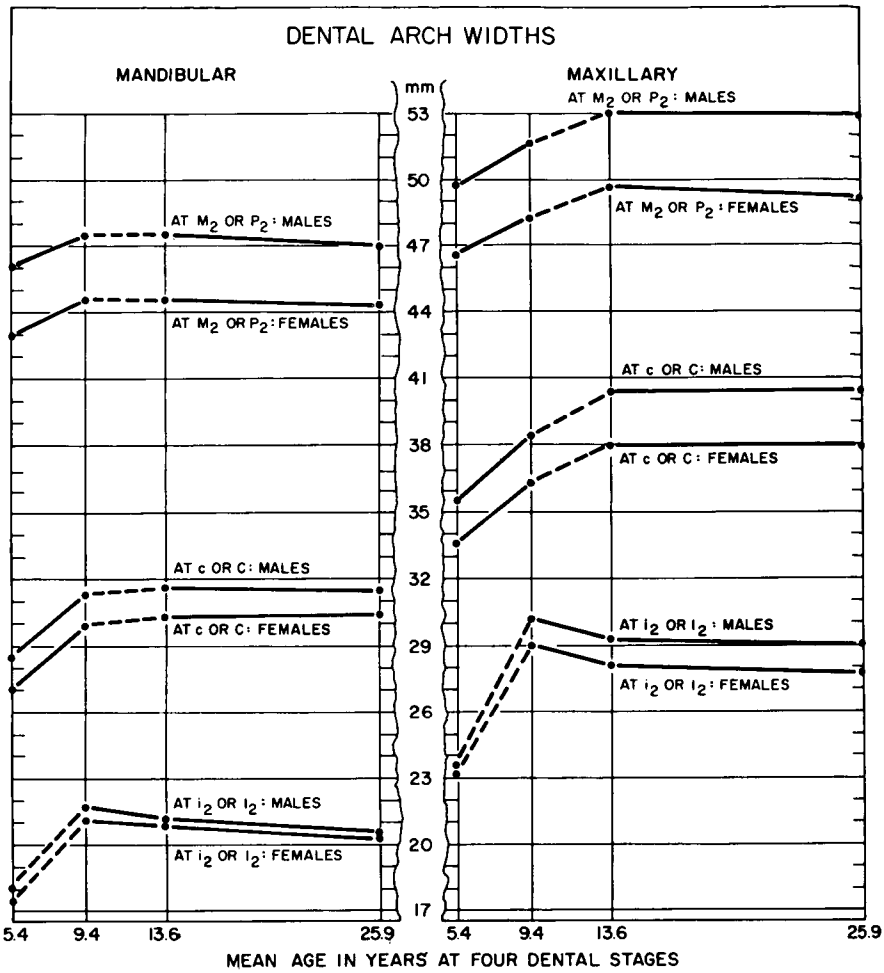

Fig. 1 Curves drawn to means from longitudinal data for dental arch width. Broken lines connect means from measurements on deciduous teeth to measurements on their permanent successors.

(average age, 5.4 years) to the stage of mixed dentition (average age, 9.4 years), mean increases for each sex are between 5.5 mm and 6.0 mm for deciduous maxillary incisor width to permanent incisor width, about 3.5 mm for the comparable mandibular arch width, 2.8 mm for both maxillary and mandibular deciduous canine widths, and between 1.5 and 2.0 mm for widths at the deciduous second molars.

4. Between the stage of mixed dentition and the attainment of permanent dentition (average age, 13.6 years), changes in average dimensions of the lower arch are small for widths between the lateral incisors and the canines. Average maximum width at the second premolars for males and females is identical with average at the second deciduous molars about four years earlier. In the maxillary arch there is a decrease in the mean width at permanent lateral incisors of 0.9 mm. Width between the permanent canine teeth averaged near 2.0 mm greater than

TABLE II

Distributions of Individual Change in Maximum Rectilinear Distance between the Lateral Incisor Teeth

Between Dentition Stages

Midpoint of Change (mm)	Mandibular Dental Arch				Maxillary Dental Arch			
	D-M	M-P	D-P	P-YA	D-M	M-P	D-P	P-YA
9					1		1	
8					7		1	
7					8		4	
6					8		11	
5	7		2		9		8	
4	16		14		2		7	
3	7	1	11				3	
2	4		5					
1	1		3	1		1		3
0		17		16		10		19
—1		16		18		14		14
—2				2		8		1
—3		1				2		
Mean*	3.52	—.41	3.11	—.59	6.27	—.93	5.34	—.33
SD	.98	.79	1.05	.49	1.25	.79	1.30	.57
SE Mean	.17	.13	.18	.08	.21	.13	.22	.09

* For each mean, the hypothesis of a true mean of zero may be rejected at the .01 level of confidence

between the deciduous canine teeth, and average width between the second premolars exceeded that between the second deciduous molars by 1.4 mm.

5. The greatest change in means over the latest period investigated (P-YA) was found for width between mandibular lateral incisors. In both sexes this value decreased 0.6 mm.

6. Over the entire span of twenty years the least change was from width at the deciduous mandibular second molars to width at the mandibular second premolars.

Results of analyses of individual changes in dental arch widths are given in the succeeding three tables. Findings on changes in width at the lateral incisors are presented in Table II. Distributions of change are shown, along with mean, standard deviation, and standard error of the mean for the intervals between stages: D (deciduous) and M (mixed); M and P (permanent); D and P; and P and YA (young adult).

The changes are analyzed for the sexes combined since analyses of changes for the sexes separately yielded no *t*'s significant at the .01 level of confidence. Changes for the same thirty-five individuals are shown in the columns D-M, D-P, and M-P. Changes between stages P and YA are shown for thirty-seven individuals, twenty-six of whom are from the above group with eleven subjects added for increased precision.

Findings on change in width at the lateral incisors are as follows:

1. Over the period from the stage of deciduous dentition (D) to the stage when permanent incisor and first molar teeth are erupted (M), two thirds of the subjects showed increases between 2.5 and 4.5 mm in the mandibular arch and between 5.0 and 7.5 mm in the maxillary arch.

2. From stage M to stage P, in each dental arch, eighty per cent of the subjects showed a decrease in width at the incisors. In the mandibular arch

TABLE III

Distributions of Individual Change in Maximum Bicanine Diameter Between Dentition Stages

Midpoint of change (mm)	Mandibular Dental Arch				Maxillary Dental Arch			
	D-M	M-P	D-P	P-YA	D-M	M-P	D-P	P-YA
7							4	
6						1	5	
5			4		1		11	
4	5		11		7	2	10	
3	24		11		15	4	4	
2	5	3	8		10	16		
1	1	11	1	4	3	12	1	9
0		16		24				18
—1		5		8		1		9
—2				1				1
Mean	2.86*	.34*	3.20*	—.09	2.82*	1.96*	4.78*	.00
SD	.59	.71	1.00	.55	.92	1.16	1.36	.63
SE Mean	.10	.12	.17	.09	.16	.20	.23	.10

* For these means, the hypothesis of a true mean of zero may be rejected at the .01 level of confidence.

all but two of the changes fell between 0.4 mm and —1.3 mm. One of the two subjects showed an increase of 2.7 mm reflecting an improvement in alignment of the incisor teeth; the other subject, a decrease of the same magnitude leading to crowding of the incisor teeth. Both subjects, in early adulthood, attained two of the less satisfactory occlusions in the sample.

3. From stage P to stage YA, an interval of about twelve years, there was decrease in width across the mandibular incisors for eighty-four per cent of the subjects, and decrease for seventy per cent of the subjects across the maxillary incisors.

Casts were available for seventeen individuals both at age 17 years and in adulthood between ages 25.5 years and 30.0 years. The mean decrease in width at the lateral incisors was 0.27 mm in the mandibular arch and 0.18 mm in the maxillary arch. For the mandibular arch the hypothesis of no decrease in width at the incisors after age 17 years can be rejected at the .01 level of confidence. A small decrease was registered for eleven of the seventeen individuals.

Distributions and statistics for individual change in maximum bicanine diameter are summarized in Table III. Findings include:

1. Width at the deciduous canine teeth increases approximately 2.8 mm in both dental arches during the period of eruption of the permanent central incisor, lateral incisor, and first molar teeth. In the mandibular arch, changes range from 1.3 to 3.8 mm; in the maxillary arch, from 1.2 to 4.9 mm.

2. Bicanine diameter on the permanent mandibular teeth averages 0.34 mm larger than the diameter on the deciduous canine teeth at stage M; in the maxillary arch the increase is 1.96 mm. There is greater variance of change in the maxillary than in the mandibular diameter.

3. On the average, there is no change in bicanine diameter in either arch after stage P. The range of individual change is from —1.6 mm to 1.1 mm for each dental arch. As for width at the lateral incisors, change from age

TABLE IV

Distributions of Individual Change in Maximum Width at Deciduous Second Molars and Their Permanent Successors

Between Dentition Stages

Midpoint of Change (mm)	Mandibular Dental Arch				Maxillary Dental Arch			
	D-M	M-P	D-P	P-YA	D-M	M-P	D-P	P-YA
5							4	
4					1		9	
3	5		8		5	4	11	
2	12	1	14		20	13	4	
1	15	10	7	1	6	10	3	1
0	3	17	3	22	3	8	1	26
—1		4	3	11				9
—2		3		3				1
Mean	1.45*	.03	1.48*	—.44*	1.83*	1.41*	3.24*	—.29*
SD	.69	.81	1.10	.65	.85	.86	1.28	.56
SE Mean	.12	.14	.18	.11	.14	.15	.22	.09

* For these means, the hypothesis of a true mean of zero may be rejected at the .01 level of confidence.

17 years to about ten years later was examined for seventeen individuals. In the mandibular arch all changes in bicanine diameter were less than 0.6 mm; in the maxillary arch the change for one individual exceeded this amount (—1.4 mm).

Table IV presents distributions and statistics on change in maximum width at the second deciduous molar and the succeeding second premolar teeth. Findings for these diameters are:

1. In the mandibular arch the greatest mean change occurs during eruption of the first six permanent teeth. Over this period, increase in width at the second deciduous molar teeth ranges from 0.4 to 3.0 mm, centering around 1.5 mm.

2. The average width at the second premolars (stage P) is no different than width measured at the deciduous second molar teeth at stage M. Individual changes vary between —1.7 mm and 1.9 mm with over seventy-five per cent showing changes in the range ± 1.0 mm.

3. There is a small average decrease between stage P and stage YA in the mandibular premolar arch width with seventy per cent of the subjects showing some decrease.

4. In the maxillary arch, over the intervals D-M and M-P, all but two individuals register an increase in both periods for the posterior width, i.e., at the deciduous second molar teeth or the second premolar teeth. Individual change from width at the deciduous second molars (stage D) to width on the succeeding permanent teeth varied from no change to an increase of 5.4 mm.

5. The majority of changes in maxillary width at the second premolars after stage P are in the direction of slight decrease; the largest positive change was 0.7 mm.

Curves of dental arch widths are shown in Figure 2 for six individuals, three with excellent occlusion and three with less satisfactory occlusion. Two of the latter subjects were noted as deviant in magnitude of increments in mandibular lateral incisor width from stage M to stage P (S38 and S50). Sample size and range of occlusion in this study are inadequate for statistical analyses of differences that might obtain between groups developing excellent and

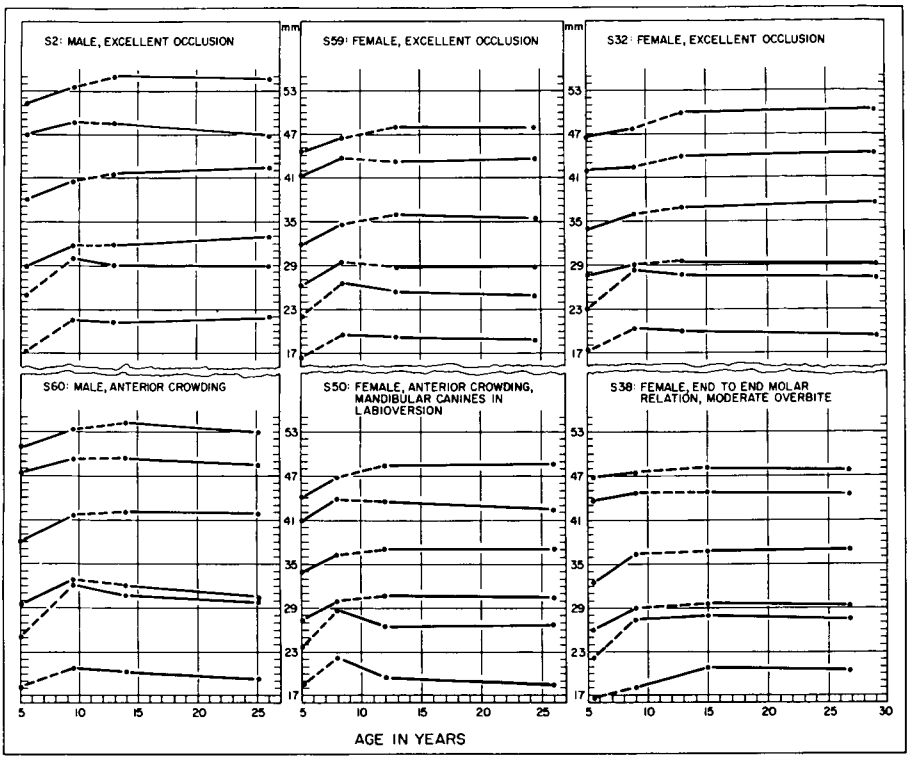

Fig. 2 Curves of dental arch width for six individuals. For each subject the lines proceeding from top to bottom represent widths at maxillary and mandibular second deciduous molars (or second premolars), maxillary and mandibular canines, and maxillary and mandibular lateral incisors. Transition from width on deciduous teeth to width on permanent successors is indicated by broken lines.

poor occlusions; the individual curves are shown for the reader to examine.

For individuals similar to the sample studied, Tables II, III, and IV may be used as reference guides in estimation of widths on the permanent dental arches from widths at earlier stages of dentition, since they show the average change and variation of change to be expected between stages. For example, the most likely change in mandibular bicanine width from deciduous to permanent dentition centers around an increase of 3.2 mm, but may vary from zero to 6.0 mm. From the standard deviation of change we may estimate that fifty per cent of the time the increase will fall between 2.5 mm and 3.9 mm; and nine times in ten, between 1.6 mm and 4.8 mm. Thus for a child with mandibular deciduous canine width of 28.0 mm at stage D, nine times in ten the comparable measure on his permanent canines can be expected to fall between 29.6 mm and 32.8 mm.

The hypothesis of zero correlation between size at stage D and change from stage D to stage P cannot be rejected for four of the six widths. For maxillary incisor width and for mandibular molar width, the average r from males and females was —.48 (df = 31). Use of a regression equation to predict amount of change from size attained at stage D (based on a correlation coefficient of .48) would improve prediction by only about twelve

per cent over the estimation of change determined from the tables.

Summary

Longitudinal data were presented for three maxillary and three mandibular dental arch widths at four stages of dentition: deciduous, mixed, early permanent, and later permanent. The widths measured in each arch are rectilinear distances at the deciduous lateral incisors, canines, and second molars, and corresponding distances on their successors.

Findings on mean size include:

1. Average size of the dental arch was greater for males than females; the differences in mean widths ranged from near 0.5 mm at mandibular lateral incisors to approximately 3.0 mm on maxillary and mandibular deciduous molars or premolars.

2. In the transition from complete deciduous dentition to permanent dentition at young adulthood, least mean change (near 1.0 mm) was registered in width from the mandibular deciduous second molars to width of their successors.

Findings from analyses of changes for individuals include:

1. Changes between stages in the six widths of the dental arch were distributed similarly for male and female subjects.

2. For the majority of individuals, maxillary and mandibular widths at permanent lateral incisors decreased from the stage of mixed dentition to the stage of permanent dentition and from this stage to young adulthood.

3. For most individuals, maximum bicanine diameter of both arches showed little change after the stage of permanent dentition was attained. In the mandibular arch, increase in this width occurred largely before the eruption of the permanent canine teeth.

4. The pattern of change in width at the deciduous second molars and their successors followed that of the canine teeth, though more individuals showed some decrease in these dimensions.

5. From tables giving the mean and standard deviation obtained for changes in widths of each arch, prediction is illustrated for individual change within chosen confidence intervals.

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