A Longitudinal Study of Developmental Changes in Human Lower Dental Arches[1]

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The physiological process of tooth eruption differs from all other growth phenomena in that the crowns of the teeth are completely formed before they assume their functional positions, that is, make their appearance in the mouth. Further than this, they have no power to change their size, or to repair, as do most other tissues. The normal occlusion of the teeth calls for a very precise placement of these organs in relation to each other both in the same and the opposing arch, to the end that cusps, fossae, and interproximal contact areas are brought into correct functional relationships.

Tooth relationships differ among animals. Thus, there are those in which there is complete independence of each tooth in both jaws; those in which the arches are divided into segments by diastemata and those in which the teeth form an unbroken row from the last molar on one side to that on the other. Man is the only example of the last type and hence the only one not having a possible area of adjustment. The correct placement of his teeth is possible only if accompanied by adequate jaw growth.

X-ray studies (Brodie '49) have shown that in the great majority of individuals the jaws are developed to a sufficient degree at birth to accommodate all deciduous teeth if they were to erupt simultaneously. The teeth of the second dentition and particularly the permanent incisors and canines, are of much greater size (9.8 mm. in the lower arch[2]) than the deciduous incisors and canines and complete the development of their crowns at staggered positions within the bodies of the jaws prior to their eruption. From these positions they erupt usually one or two at a time, the lowers preceding the corresponding teeth of the upper arch.

The eruption and accommodation of the permanent teeth has been the subject of investigation and discussion for nearly two hundred years. In the past fifty years it has come to hold great interest for dentists who devoted their attention to adjusting occlusal disharmonies for the promotion of masticating efficiency and esthetics. Considerable research has been directed toward determining the changes in arch form and size that accompany the transition from deciduous to permanent dentition.

One of the first statements on this subject was that of Hunter,[8] who wrote, "The jaw still increases in all points till twelve months after birth, when the bodies of all the six teeth (the five deciduous teeth and first permanent molar) are pretty well formed; but it never after increases in length between the symphysis and the sixth tooth; and from this time, too, the alveolar process, which makes the anterior part of the arches of both jaws, never becomes a segment of a larger circle, whence the lower part of a child's face is flatter, or not so projecting forwards as the adult."

Later in this same book, he commented on the teeth within the arch,

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as follows, ". . . as that part of each jaw which holds the ten fore teeth is exactly of the same size when it contains those of the first set as when it contains those of the second, and as these last often occupy a much larger space than the first, in such cases the second set are obliged to stand very irregularly. This happens much oftener in the upper jaw than in the lower, because the difference of the size of the two sets is much greater in that jaw."

Black[2] found a difference of 2.6 mm. between the sum of the average mesiodistal diameters of the lower deciduous teeth and the sum of the average mesiodistal diameters of their succedaneous teeth. The sum of the deciduous was less than that of the succedaneous. But, he simultaneously found that the sum of the average mesiodistal diameters of the six permanent anterior teeth was 9.8 mm. larger than that of the six deciduous anterior teeth. This immediately poses the question of how the 9.8 mm. of additional tooth structure of six anterior permanent teeth is accommodated when the total increase from deciduous to permanent dentition is only 2.6 mm. Is the discrepancy entirely made up by premolars that are correspondingly smaller than their predecessors?

Angle[1] wrote, "The permanent teeth being larger and more numerous than the deciduous, the greater space required by them is provided by the broadening of the dental arches in the region between the canines, and the lengthening of their lateral halves, posterior to the deciduous molars."

Keith and Campion[9] expressed the belief that the statement is by no means well supported that holds that the buds of the mandibular premolar teeth erupt and occupy the same relative position in the mandible as the deciduous molars did in the young child.

Brash[3] states, ". . . the increase of the alveolar bone by surface additions leading in the maxilla to a strong downward, outward and forward movement of the alveolar arch, and in the mandible to a similar movement of less extent and somewhat different character, is important from three points of view: (1) the addition to the height of the jaws that is thereby achieved; (2) in relation to the eruption of the teeth; (3) in relation to the changing form of the alveolar arches."

He also wrote, ". . . the arches (of the deciduous and the permanent dentitions) are not identical, the succession is not an exactly vertical succession, the characteristic form of the deciduous arch is changed to the characteristic form of the permanent arch by growth in width of the posterior part of the arch, which takes place during the tooth change, and by the non-vertical succession of the anterior teeth; moreover, as a result of the addition to the length of the face during the period of change by general growth of the alveolar bone, the arch is entirely reconstituted and comes to occupy a new plane relative to the body of the jaw."

Brash also quotes Franke as saying that the width of the base of the arches increased, and that the arch length decreased.

Lewis and Lehman[10] in a study of six hundred serial models taken of one hundred seventy children's developing dentures (malocclusions included) found that between three and eight years of age the distance between the lower canines (measured on a transverse line) increased an average of 2.40 mm. and the distance between the two lower first deciduous molars increased an average of 1.27 mm. The distance between the lower second deciduous molars increased an average of 2.12 mm. This alone would indicate an increase in arch length mesial of the first permanent molar, provided there was no mesial migration of these teeth.

Goldstein and Stanton[7] traced and analyzed five hundred forty-six serial casts of three hundred children's dentures. Malocclusions were not excluded. Their findings were very similar to those of Lewis and Lehman, differing in degree only. They also determined that the centroids* of the lower canines were closer to a line tangent to the labial of the central incisors by about .2 mm., and the centroids of the lower second deciduous molars were 1.7 mm. closer to the canines at nine years than at two years. They described the changes in form, using a system of indices which showed a flattening of the anterior segment and changes in the posterior segments.

Cohen[6] examined serial models of the developing dentures of twenty-eight children with fairly normal arches. He found that the greatest growth takes place in the inter-canine width while the anterior permanent teeth are erupting. He found small increases in the transverse distance between the deciduous molars and between first permanent molars. A significant decrease in the anteroposterior space between the lower canine and the lower first permanent molar was noted.

Sillman[12] found that the mandibular inter-canine width usually increased in three distinct periods; from birth until just before the deciduous canines erupted, while they were erupting, and while the permanent incisors and canines were erupting. This pattern tended to be more pronounced in good occlusions.

A search of the literature revealed only one attempt to measure arch length along a line determined by the contact areas. Nance[11] measured arch length from the mesial surface of one lower first permanent molar to the other, by measuring straight segments of the line with dividers and determining the sum. He observed cases of malocclusion or suspected developing malocclusion in order to correlate arch length with prognosis of treatment. Nance claimed that the natural "leeway" or average loss on each side of the lower arch was 1.7 mm. between the mesial surface of the first permanent molar and the distal surface of the permanent lateral. This occurred during the transition from deciduous canines and molars to permanent canines and bicuspids. Nance arrived at this figure by calculation from Black's tables for the average sizes of deciduous and permanent teeth.

The object of the present investigation was to observe the natural changes that occurred in lower arch length and form from the time the deciduous denture was completed until the permanent first molars, incisors, canines, and bicuspids were in occlusion. Arch length was measured along the line determined by the approximate centers of the contact areas. The natural behavior of the line determined by the center of the contact areas deserves special investigation, since ultimately, it is the line along which teeth of a fixed size must be placed, like beads on a string. The study was restricted to those series which developed into very good permanent dentures.

The sum of the greatest mesiodistal diameters of the individual teeth and

* "The most centrally situated point of the tooth as a whole. This is determined by the point of intersection of the central mesio-distal and bucco-lingual diameters." Page 900. F. L. Stanton, G. D. Fish and M. F. Ashley-Montagu. Description of Three Instruments for Use in Orthodontic and Cephalometric Investigations, With Some Remarks on Map Construction. The Journal of Dental Research, Vol. XI, No. 6, Dec. 1931, 885-902.

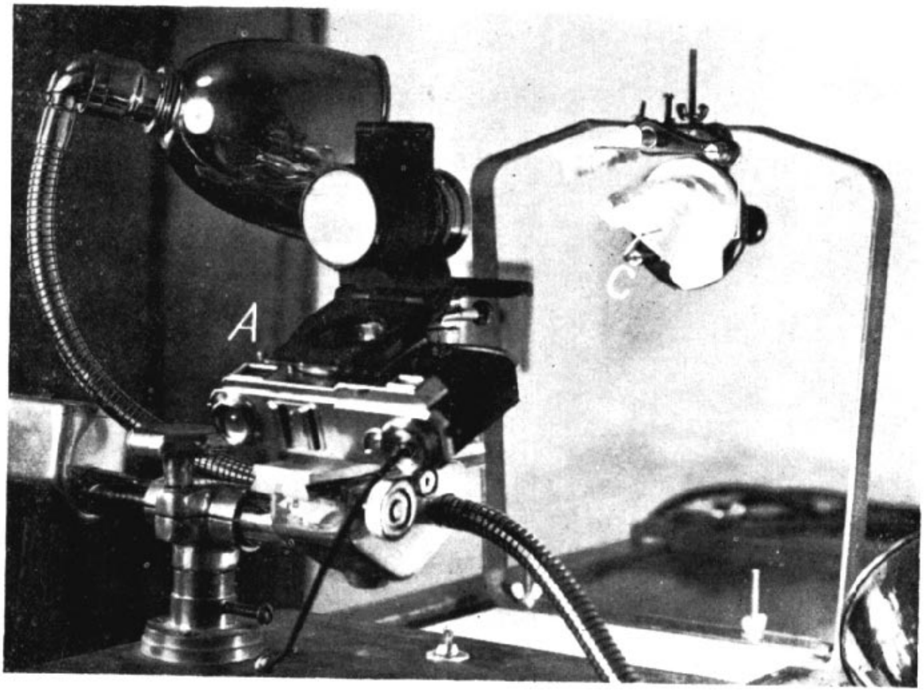

Fig. 1. The Photographing Device (frontal view). A. The camera; B. The pointer; C. The model positioning device.

the arch length, may not be identical. Some arches present spacings while others exhibit rotations and other conditions which lead to arch shortening without affecting mesiodistal diameters. For this reason, the arch length was measured, and not the greatest mesiodistal diameters of the individual teeth.

The changes that occur after the permanent incisors, canines, and bicuspids have come into occlusion, or changes due to aging or pathology are not within the realm of this study. For the remainder of this paper, when we refer to the lower permanent dentition, we shall mean the lower permanent teeth mesial to the second permanent molar. The presence or absence of the second or third permanent molars is irrelevant.

Method

The method employed in the present study consisted of photographing oriented plaster casts of human lower dental arches at a fixed focal distance. The negative films were projected to a common enlargement (3X) and these images were traced and measured. The photographing devise used is shown in Figures 1 and 2. It consisted of a Zeiss Contax 35 mm. camera, an adjustable model positioning device, a pointer, and lights, all mounted on a common base. The camera was equipped with an *f* 2.5 lens and an auxiliary portrait lens, to yield a large image on the negatives. The film used was Eastman's Safety Positive which is of extremely fine grain on a clear backing. The camera was mounted on a movable carriage which permitted forward or backward movement for focusing with the Speedocopy ground glass (Figure 1.) and could be fixed firmly in the desired position with a screw. After focusing, the ground glass was turned up and the camera swung into position.

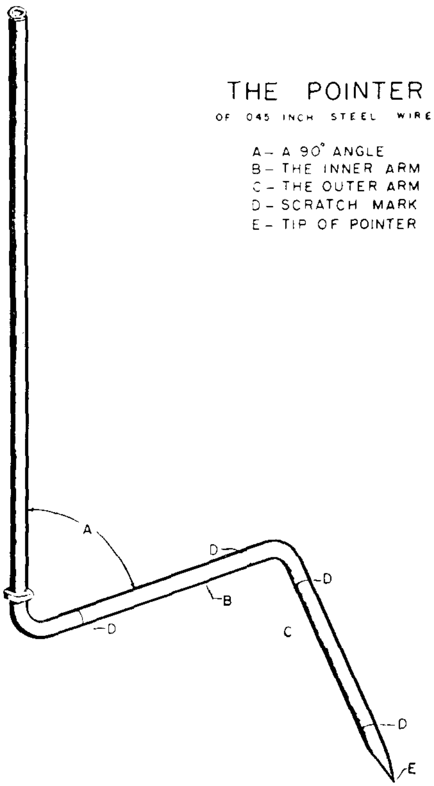

Fig. 2. The Pointer.

A suitably mounted Roach Guide Design (surveyor) was used to position the model. This device consists of a rotary circular base from which three threaded posts project to provide for orienting the model in the desired plane. For the purpose of this study, the base was mounted perpendicular to the optical axis of the lens which was directed at the center of the base. A sliding horizontal post supporting the base provided for movement along this axis, that is, toward or away from the camera. Such movement was necessary to adjust for variations in the height of the models. The plaster cast was clamped tight against the three supporting posts with a thin metal disc interposed to prevent penetration of the plaster.

The apparatus was completed by a pointer assembly consisting essentially of a base and a pointed .045 inch steel wire, bent as shown in Figure 2. The two terminal segments of the wire lay in the same plane. This plane was perpendicular to the third segment of the wire. There were two fine scratches one inch apart on each of the terminal segments (Figure 2.) of the wire. This pointer had the double purpose of orienting the model in the desired position and of providing for critical focusing.

The lighting consisted of two No. 1 photoflood lamps and reflectors placed as shown in Figure 1.

Each model was carefully oriented in such a way that three interdental contact areas were in the same plane as the terminal arms of the pointer. The contact areas used were that between the central incisors and those between the deciduous molars on each side. If the first permanent molars were present, their mesial contacts were used. When the orientation of each model was complete, the pointer was moved close enough to be included in the field. Exposure was made for one-tenth of a second at *f*. 18. It was not necessary to change the camera position or to focus, during the exposure of an entire roll of film, or during the changing of film.

The processed negatives were projected by means of a Leitz Focomat I enlarger (Fig. 3) on a special easel and the image was brought to a fine focus on a sheet of white paper at 3X magnification by measurement of the scratch marks on the pointer arms. The distances between the scratch marks were constant for all of the negatives on any roll of thirty-six exposures and the enlarger required only the initial adjustment. Each projection was identified by the name and age of the individual.

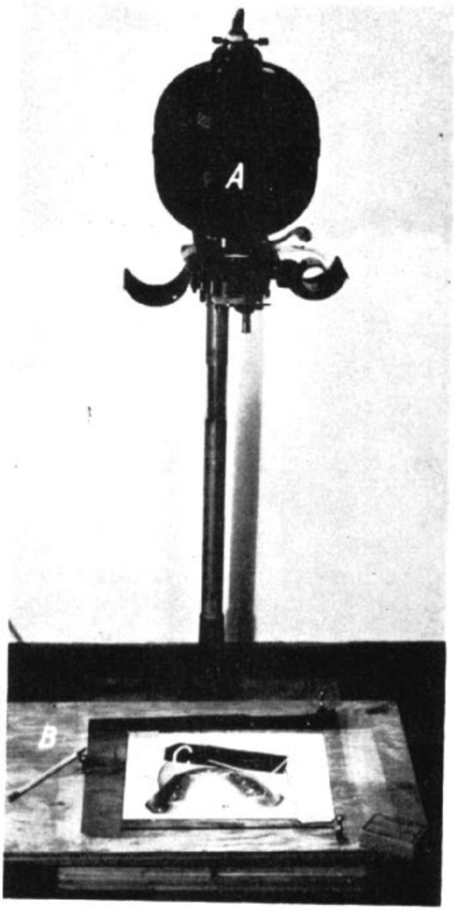

Fig. 3. The Projecting Assembly. A. The Enlarger; B. The Easel; C. The Image.

The greatest outline of each tooth shown in the projected image was traced with a hard pencil and a positive print was made of most of the cases for subsequent reference. The center of each physiologic contact area (that is, the point where the teeth met, in contrast to the anatomical) was located on the tracing with allowances for slight rotations or open contacts. If a circle could be drawn which passed through all or most of the contact areas of the incisor and canine teeth, it was constructed by the bisection of two chords. If this proved impossible, the centers were connected by a smooth curve. Tracings of successive models of the same series were used to check the consistency of the contact areas selected. Straight line segments were used between the canines and last buccal teeth.

Since the teeth actually represent straight line segments of the curved arch, and transmit forces over these straight lines, the arch length was measured as the shortest distance between successive physiological contact areas. Dividers were used to transfer each segment on the tracing to a *straight line,* with notations to denote the following: (1) the center of the contact area between the centrals, or the center of the space between them if there was no contact; (2) the center of the distal contact area of the canines; (3) the center of the distal contact area of the second deciduous molar or the mesial contact area of the first permanent molar if that tooth was present.

The following measurements were taken from the straight line and divided by three (since the tracing was magnified 3x). (1) from the distal of the left canine to the distal of the right canine; (2) from the distal of the left second deciduous molar to the distal of the same tooth on the right or; (3) from the mesial of the left first permanent molar to the mesial of that on the right, when these teeth were present. In those cases where it had been possible to draw a circle through the contact areas, the radius of the circle was divided by three. A notation was made to indicate whether the circle had a very good relation to the contact areas or if the relation was only fair.

In order to test the validity of the method, small marks were placed in the plane determined by the contact areas on each of twenty-two models, and the models were photographed and traced. The distances between the traced marks were compared to direct measurements of the models.

The distances between the points were then measured directly on the models again, to determine what difference could be expected between consecutive direct measurements. The absolute and percentage difference for each of these distances was derived and recorded.

The average percentage difference which resulted from two separate direct measurements of the models was .46%. The average percentage difference between the first direct measurement and the measurement taken from the projected image was .52%. The first direct measurement was considered to be the most accurate. (In some instances, the first direct measurement removed the fine marks to an extent that made a second direct measurement difficult. The largest percentage difference between the direct measurements was 1.6 and the largest percentage difference between the first direct measurement and the measurement computed from the enlargement was 2.4%.

No ideal fixed points were available for superimposing the outlines of the arches to show the changes in form that took place in each longitudinal series. However, for the purpose of analyzing changes in form, the tracings of the arches were superimposed as follows: (1) a transverse straight line was drawn connecting the distal contact areas of the lower second deciduous molars, or the mesial contact areas of the lower first permanent molars if present; (2) this line was bisected; (3) the point of bisection was connected by a straight line to a point representing the center of the contact area between the centrals; (4) these lines were superimposed with the center of the contact area between the centrals registered. Construction of this line is shown in Figure 12.

Material

The material used in this study consisted of serial models of children's lower dental arches in the stages of the deciduous, mixed, (part deciduous and part permanent) and permanent dentitions and was derived from various sources; that is, Merrill-Palmer School, Detroit, Michigan; Child Research Council, University of Colorado; Institute of Child Welfare, University of Minnesota; and the Department of Orthodontia, University of Illinois. At all of these places periodic records had been made of growing children and each child was represented by a series of such records.

For the purposes of this study only those series were selected which showed development into very good occlusion in the permanent dentition. No malocclusions, treated or untreated were included. From each series the following stages were selected for analysis: (1) the complete deciduous-dentition, (2) the first model after the eruption of the lower first permanent molars, (3) the first model after the eruption of the lower bicuspids. In some instances earlier or later models were included for special reasons. Fifty-three series were studied with a total of one hundred and seventy models.

Findings

To compare the arch length of the lower deciduous teeth to the arch length available for their succedaneous teeth, the distal contact areas of the second deciduous molars were used for the deciduous dentition and the mesial contact areas of the first permanent molars were used as landmarks for the permanent dentition. (Since the mesial contact area of the lower first permanent molar almost always comes into contact with the distal contact of the second deciduous molar before the latter is exfoliated, the mesial

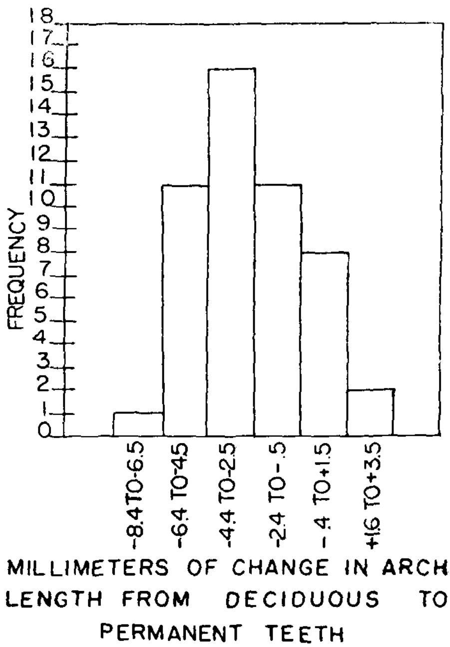

Fig. 4. Changes in Arch Length during the Transition from Deciduous to Permanent Dentition.

contact area of the first permanent molar can be considered as a landmark comparable to the distal contact area of the second deciduous molar.) When this was done, the total arch length occupied by the deciduous dentition was found to be greater than the total arch length available for the succedaneous teeth in forty-one out of forty-nine series. In seven series, there was more arch length available for the succeeding permanent teeth than was occupied by the deciduous teeth, and in one series the two were equal. The maximum increase in arch length during the transition from deciduous to permanent teeth was 2.1 mm., while the maximum decrease was 6.7 mm. The histogram shown in Figure 4 demonstrates the ranges and frequency of the differences. The mean was a decrease of 2.6 mm., and the mode was a decrease of 4.8 mm. The standard deviation was 2.1 mm.

After the arch length of the lower deciduous denture had been compared to the arch length available for the corresponding lower succedaneous denture, the arch length available mesial to the first permanent molar in the *mixed* dentition was compared to the arch length available mesial of the first permanent molar in the corresponding permanent dentition. The mesial contact areas of the first permanent molars were used as landmarks. Comparison revealed that the total arch length available for the permanent teeth mesial to the first permanent molar was less in forty-two out of forty-seven cases than the total arch length available for the mixed dentition mesial of the first permanent molars. In four series there was more arch length available in the permanent than in the mixed dentition, and in one series there was no change. The greatest increase from mixed to permanent dentition was 1.5 mm. and

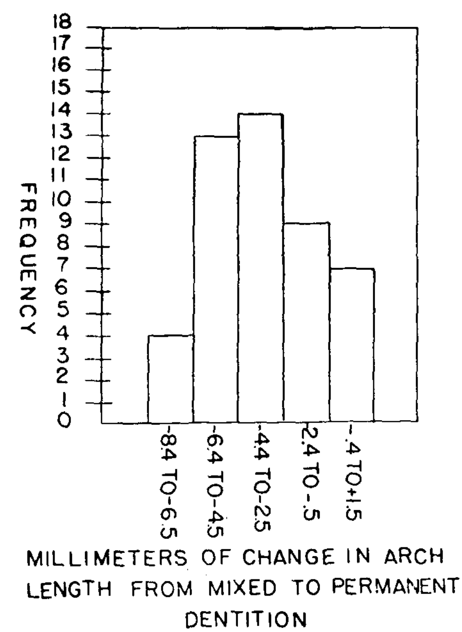

Fig. 5. Changes in Arch Length during the Transition from Mixed to Permanent Dentition.

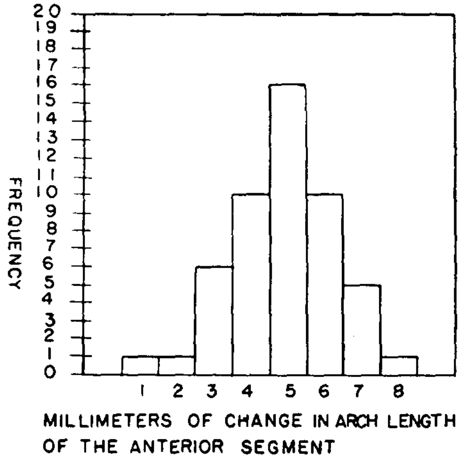

Fig. 6. Changes in Arch Length from the Distal Contact Area of One Cuspid to that of the other during the Transition from Deciduous to Permanent.

the greatest decrease was 8.2 mm. Figure 5 demonstrates the range and frequency of the changes. The mean for the forty-seven series was a decrease of 3.5 mm., while the mode was a decrease of 6.8 mm. The standard deviation was 2.4 mm.

When the anterior portion of the arches was measured, that is, from the distal contact area of one canine to that of the other, an *increase* was demonstrated in all cases during the transition from deciduous to permanent dentitions. The average increase was 5.0 mm. with a range of 1.1 to 8.5 mm. Figure 6 shows the extent and frequency of the changes. The standard deviation was 1.0 mm.

The contact areas of the six anteriors usually formed a segment of a circle which could be constructed geometrically. This was true for one hundred fifty-three of the one hundred seventy models examined. On seventeen models it was impossible to construct a circle which could be considered typical of the contact areas of the six incisors. In forty-six series out of 53 series it was possible to construct circles for *both* the deciduous and permanent models. In seven series it was impossible to construct this circle on the tracing of the deciduous dentition or the permanent dentition or both. The radius of this circle increased during the transition period from complete deciduous to permanent dentition in forty-four series. In two series the radius decreased. The extent and frequency of the changes are shown in Figure 7. The average was an increase of 1.8 mm. in the radius of the circle. The greatest increase was 4.9 mm. or 33%. The greatest decrease was 1.3 mm. or 8% decrease. The mode was an increase of 1.2 mm. The standard deviation was 1.2 mm.

When the tracings of the deciduous and permanent arches were superposed on the mid-line of the denture, and registered at the contact point between the centrals, changes in both form and dimension could be observed. This demonstrated that during the transition from the deciduous to the mixed dentition, the anterior segments of most of the series became flatter, that

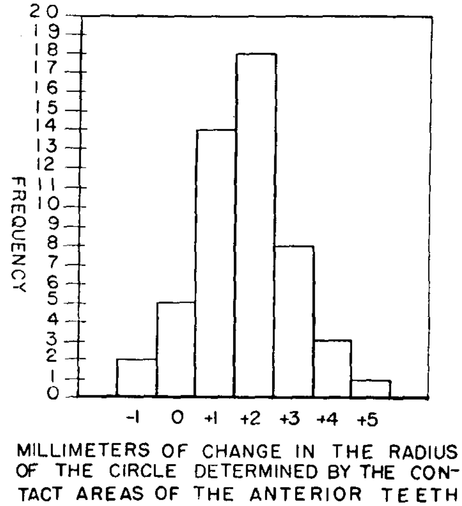

Fig. 7. Changes in the Radius of the Circle Determined by the Contact Areas of the Anterior Teeth during the Transition from Deciduous to Permanent Dentition.

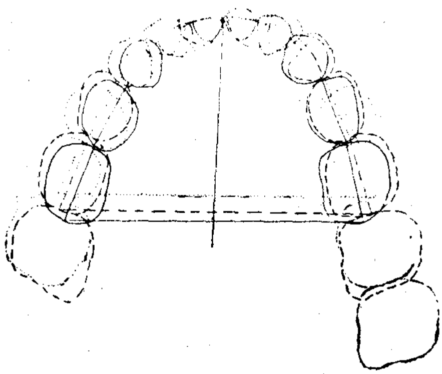

FIG. 8. THE USUAL CHANGES IN ARCH FORM AND LENGTH
Deciduous Dentition, solid line; Mixed Dentition, broken line; Permanent Dentition, dotted line.

is, a segment of a larger circle. The posterior segments usually expanded. In the transition from mixed to permanent dentitions the same tendencies were apparent. In some cases, changes were so slight that it was difficult to determine any alteration in form.

A great variety of changes in form were found. The outlines of the arches of the deciduous, mixed, and permanent models of case E. R. are shown in Figure 8. These changes in arch length and radius represent average values and are an example of the changes that took place in arch form in the majority of the arches studied.

There were several types of arch changes. Figure 9 represents an example of extreme expansion in the cuspid area and posterior segments. Figure 10 represents a series which did not change greatly in either outline or arch length. Figure 11 represents a series which increased in arch length due to change in form.

A large majority of the cases indicated a decrease in the anteroposterior dimension of the arch during the transition from deciduous to mixed and from mixed to permanent dentition when this was measured along the midline from the central incisors to a transverse line connecting the mesial contacts of the first permanent molars.

Discussion

One of the most common problems confronting those who attempt to adjust occlusal disharmonies of the teeth for the purposes of improving their function and their appearance is a lack of sufficient arch length in the lower jaw. Although the jaws are adequately developed at birth to accommodate the ten deciduous teeth in the maxilla and mandible, the larger permanent teeth which follow them are frequently crowded. Some of this crowding is of a temporary nature and is due to various types of disharmonies between jaw growth and the eruption pattern of the teeth.

Jaw growth has been shown to be a steady and orderly process, but variation exists among individuals in the matters of timing and rate.[4] Tooth eruption, similarly, shows wide variations in the order or sequence, and in time. Thus, the situation presents a growth phenomenon in which a discontinuous variable (tooth eruption) must be correlated with a continuous variable (jaw growth) if normal occlusion is to be the ultimate outcome. No effort has been made in this study to investigate this correlation; rather,

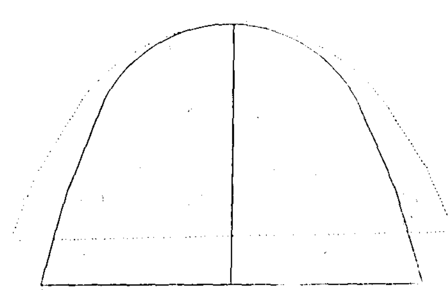

FIG. 9. AN UNUSUAL CASE EXHIBITING EXTREME EXPANSION IN THE CANINE AREA AND POSTERIOR SEGMENTS
Deciduous Dentition, solid line; Permanent Dentition, dotted line.

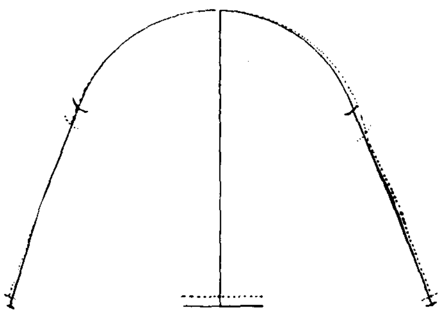

FIG. 10. AN UNUSUAL CASE EXHIBITING LITTLE CHANGE IN FORM OR ARCH LENGTH

Deciduous Dentition, solid line; Permanent Dentition, dotted line.

the factor of jaw growth has been eliminated by selecting only those cases which have developed into good occlusions. A number of these exhibited stages in which certain disharmonies existed for a time. Attention has been directed only to arch length and arch form.

Black[2] stated that the combined average mesiodistal diameters of the lower deciduous teeth was less by 2.6 mm. than was the combined average mesiodistal diameters of the succedaneous teeth. According to his averages, the arch segment including the permanent canines and incisors was 9.8 mm. larger than the deciduous, while the bicuspid segments were 7.2 mm. smaller than the segments occupied by the first and second deciduous molars which preceded them. It should be pointed out that Black's measurements were made on different groups of individuals representing different ages and that the measurements were probably laid out on a straight line.

For the purposes of the present study, the same individuals were measured at different age levels and the measurements were made from contact point to contact point as the teeth were found arranged. Arch length, therefore, denotes circumferential arch length. This method of measurement revealed that the arch length of the deciduous dentition was greater than that of the succedaneous teeth in the majority of cases although 14% of the sample exhibited greater arch length in the permanent dentitions. Figure 4 shows the frequency and range of the changes.

When the arch lengths formed by the six anterior teeth, deciduous and permanent, were compared, it was found that the latter were, on the average, 5 mm. greater than the former. There was no case in which the deciduous was as large as its permanent successor. On the other hand, the arch lengths between the canines and the mesial contacts of the first permanent molars were always found to be greater in the deciduous dentures. The average difference (for both sides) was 7.6 mm. This does not mean that the bicuspids are always smaller than the deciduous molars; occasionally spacing of the deciduous denture contributed to the difference.

The question immediately arises as to how the permanent dentition can be accommodated in an arch that is smaller than that formed by deciduous teeth. In addition to the relative differences between the anterior six and posterior four teeth, there are variations in arch form which apparently contribute significantly to an adjustment of the above discrepancies.

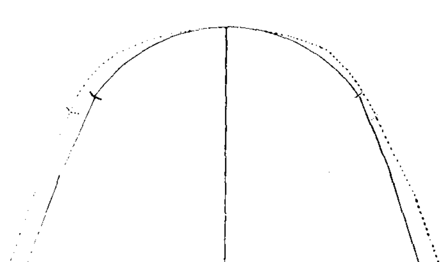

FIG. 11. AN UNUSUAL CASE EXHIBITING INCREASE IN ARCH LENGTH

Deciduous Dentition, solid line; Permanent Dentition, dotted line.

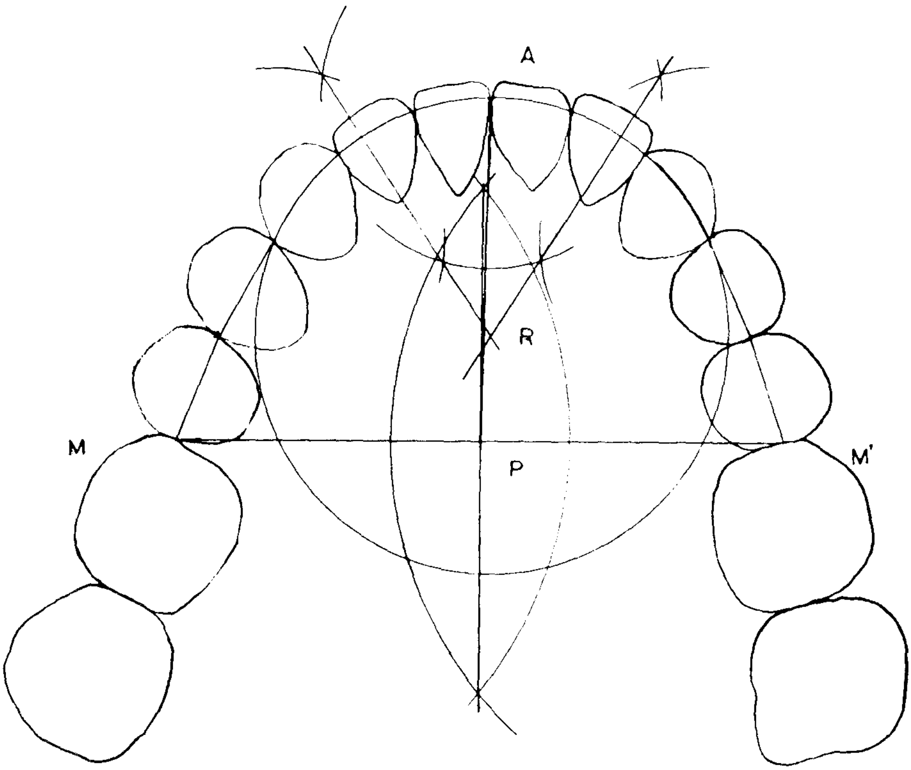

FIG. 12. CONSTRUCTION OF THE LINES FOR SUPERPOSITIONING
A. The contact area between the central incisors; M. The mesial contact area of the right first molar; M'. The mesial contact area of the left first molar; P. The mid-point of M M'; R. The center of the circle determined by the contact areas of the anterior teeth.

Superpositioning of successive tracings of the same individual on the midline and with the interincisal contact point registered revealed that the arch formed by the permanent teeth usually was flatter in the incisal and canine area than was that formed by the deciduous teeth (Figure 7). Further than this, the posterior segments were disposed further laterally. This is contrary to Hunter's[8] contention that ". . . the arch never becomes the arc of a larger circle. . . ." It agrees with the statements of Angle,[1] Brash,[3] Lewis and Lehman,[10] Goldstein and Stanton,[7] Cohen,[6] and Sillman,[12] most of whom reached their conclusions by measuring between corresponding points on the two sides of the arch.

Arch length has frequently been measured along the midline from a base constructed between corresponding bilateral dental points and the interincisal point. This is shown to be misleading because a decrease in the length of this line if accompanied by an increase in width, may be found in association with an actual increase in circumferential arch length. Such a case is shown in Figure 11.

In order to understand the outcome of the transition period of the human dentition, it is necessary to realize that at least four variables are operating. These are (1) the relative sums of the mesiodistal diameters of the teeth of the two dentitions, (2) the relative differences existing between the sizes of the six anterior and four posterior teeth at both stages, (3) the amount of spacing, and (4) changes that may occur in the form of the arch. The latter may and frequently do influence circumferential arch length. These variables seem to be independent and hence may result in additive values or they may cancel each other.

In almost all cases, there was a shortening between the inter-central contact area and a line connecting the mesial contact areas of the first permanent molars. As stated above, this distance has frequently been referred to as arch length. We prefer to call it arch depth. It is generally thought that such shortening is the result of a forward movement of the first permanent molars but until a method is discovered to relate the denture to some point of reference outside of the dental area, it will not be possible to state with assurance that it is due to such molar movement and not to a posterior movement of other teeth.

Summary and Conclusion

A method is described for the measurement of dental arches by means of controlled photography and the enlargement of the resulting negatives.

Findings made on the same individuals as they progressed from the stage of the complete deciduous dentition to that of a normal succedaneous dentition plus first permanent molars revealed that:

1. The deciduous arch length, when measured along the line formed by the contact points was usually greater than that formed by the corresponding permanent teeth.
2. The six anterior permanent teeth of the lower arch always occupied more arch length than their deciduous predecessors.
3. The deciduous molars were almost always larger than the bicuspids which succeeded them.
4. In the majority of cases the form of the dental arch changed during the transition from complete deciduous to permanent dentition becoming flatter and wider in front and wider in back.
5. The three factors studied, that is, the total arch length, the relative differences between the combined sizes of the anterior six and posterior four teeth, and the form of the arch, appeared to be independent variables which could result in increased arch length in some cases or could cancel each other in other cases.

The study seems to warrant the conclusion that no one of the factors studied can be used alone as a sure guide in predicting that a given deciduous denture will develop into a normal or abnormal permanent denture.

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