Changes Of Intermolar And Intercuspid Distances Following Orthodontic Treatment

SHERWOOD R. STEADMAN, D.D.S., M.S.
St. Paul, Minnesota

To all orthodontists the question arises sooner or later concerning the permanency of changes produced during the period of orthodontic treatment. This study was undertaken to answer this question.

HISTORY

History records many who have studied the face, teeth and jaws. Most were trying to establish a "norm" or to see the manner in which a "normal" child's face, jaw and teeth grow. One of the first was John Hunter, 1771, who set down the principles of jaw growth, alveolar bone growth, and dental arch form. He was followed by Fox in 1790 who published a text showing the manner in which (1) the mandible grows, (2) the permanent teeth replace the deciduous teeth, and (3) space is obtained so that the molars may successively erupt. In 1891 Charles Tomes published a "Study of Growth of Jaws", and similarly studies by Zsigmondy 1890 and Wallace in 1911 and 1927 presented studies on normal jaw growth. Colyer in 1920 was the first to record a study of changes in the dental arches during childhood. In 1929 Lewis and Lehman published "Observations of the Growth Changes of the Teeth and Dental Arches". B. Holly Broadbent, 1937, published the patterns by which the faces, jaws, teeth, and dental arches of healthy children grow; this was obtained from material which he collected at the Bolton Foundation. In 1940 Cohen published "Growth and Development of Dental Arches in Children". Brodie, in 1948, wrote "Growth of the Jaws and the Eruption of the Teeth". In 1950 Woods compared the dental arch with facial width. In 1953 Scott reported on individual variation in facial growth.

In none of the literature was the author able to find any definitive study showing the amount the intermolar and intercuspid distances changed during orthodontic treatment, orthodontic retention, and thereafter. Accordingly the following study was undertaken to obtain such information. Then Walter, 1951, presented a report on this very same subject. It was decided, nevertheless, to continue as planned and to present the findings in a different manner.

PROCEDURE

From the files of the orthodontic department of the University of Minnesota the first thirty-one records containing models before orthodontic treatment, at the completion of orthodontic treatment, and one or more years after termination of retention were used for this study. The beaks of a Boley micrometer were filed to a knife edge at the measuring surfaces. Using this micrometer measurements in tenths of millimeters were made of intermolar and intercuspid distances between the central fossae of the molars and the center of the tips of the cuspids. These measurements were made on the plaster models and recorded on a separate sheet for each patient. This record sheet contained spaces for the measurements of the models before orthodontic treat-

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ment, at the completion of orthodontic treatment, and one or more years following removal of retention. Some patients had models at the end of retention so measurements were also made on these as an additional unplanned study. A record card for each patient was made on which were recorded in tenths of millimeters the differences between the above measurements. These differences, plus and minus, were used in the succeeding charts.

Presentation of the results in a readily understandable form became one of the more difficult tasks of the study. Charts, such as Walter used, present the measurements in the most accurate and composite manner, but are quite difficult to interpret. The method finally decided upon was to gather into single millimeter groups those patients with identical amounts of change, i.e., those between minus four tenths and plus five tenths of a digit were combined into the single group of that digit, and to chart these groups for each dimension studied.

Introduction to the Charts

It should be emphasized that this is not a quantitative study to determine how many patients' records behaved alike in each group. Rather, this is a qualitative study to determine just what amount of change occurred as shown by the groups.

Charts (a) and (b) Figure I show three more patients than those of Figure 2 because in one patient the upper dentition was treated and lower dentition was not, so the intermolar and intercuspid dimensions of the lower dentition were not included in the measurements, but the upper measurements were recorded, while the other two had models with broken molars. Hence Charts (a) and (b), Figure 1 show thirty-one measurements while those of Figure 2 show only twenty-eight measurements. Similarly in Charts (a) and (b), Figure 3, there are seventeen measurements of the upper intercuspid distance; in Figure 4 there are twenty-two measurements and both are less than the number in Figure 1 and Figure 2. This is because the intercuspid measurement was not recorded for those whose cuspids were not yet sufficiently erupted to permit the placement of orthodontic bands.

As mentioned previously, Charts (c) and (d) are included as an additional unintended study to demonstrate the changes which occurred during retention and the year or more following retention. Many patients did not have models at the end of retention, and so the number of records is less than in Charts (a) and (b). In Figures 3 and 4 Charts (d) show more records than Charts (c) because by the time of retention many of the previously not fully erupted cuspids had completed their eruption and so could be measured. This in no way invalidates the study, but emphasizes the accuracy of the method since no questionable measurements were recorded.

Changes Between The Upper Permanent Molars

Figure 1, Chart (a) presents the distance changes between the upper permanent first molars which occurred during the time interval from four up to as many as ten years, i.e., between the start of orthodontic treatment and the one or more years following removal of all retention appliances, which is called the ultimate measurement. The variation between groups of patients is striking: one patient's intermolar distance decreased four millimeters, two patients' intermolar distances increased five millimeters, and six patients presented no change whatsoever in their intermolar distance.

The question then arises as to how

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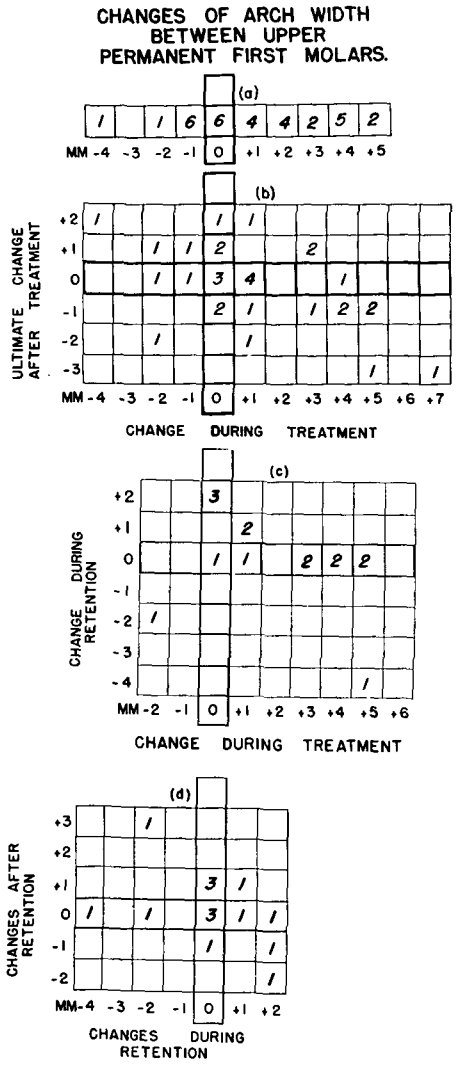

Fig. 1

much of this change may be the result of orthodontic treatment. *Figure 1, Chart (b)* shows in the vertical columns the changes which occurred in these same patients during their periods of orthodontic treatment, in the horizontal columns the changes which occurred between the end of treatment and one or more years following the period of retention (the ultimate). In the upper left quadrant is one patient whose intermolar distance decreased four millimeters during treatment, yet increased two millimeters after treatment (+2, −4), thus the resultant change is a decrease of only two millimeters and is recorded in the minus two-millimeter box in Chart (a). In the lower left quadrant Chart (b) is a patient, (−2 −2), whose intermolar distance decreased two millimeters during treatment and continued to decrease another two millimeters following treatment, the resultant total decrease is four millimeters which is registered in the minus four millimeter box in Chart (a). Similarly in Chart (b) in the extreme lower right quadrant is a patient (−3, +7), whose intermolar distance increased seven millimeters during treatment but decreased three millimeters following treatment thus producing a resultant increase of four millimeters. This patient is registered with four others in the plus four millimeter box in Chart (a). In the upper right quadrant of Chart (b) are two patients, (+1 +3), whose intermolar distances increased three millimeters during treatment and continued to increase an additional one millimeter following treatment, thus producing a resultant increase of four millimeters; these patients are registered with three other patients in the plus four millimeter box in Chart (a). Three patients presented no change in intermolar distance during or following treatment and are registered in the zero intersection of the horizontal and vertical columns of Chart (b) and in the zero box along with three other patients in Chart (a). Thus in some patients the change may be due to orthodontic treatment, since no change occurred after orthodontic treatment; in other patients changes did occur following orthodontic treatment which totally or partially eliminate the change during treatment, others continued in the same direction

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as that which occurred during treatment.

From the records presented in the preceding charts it seems that the distance between the upper permanent molars will remain the same as at the end of the period of treatment only in those patients in whom the attained position is in harmony with all of the other forces acting upon those molars.

Thus orthodontic treatment does not determine the ultimate upper intermolar width; other forces and factors also influence this distance.

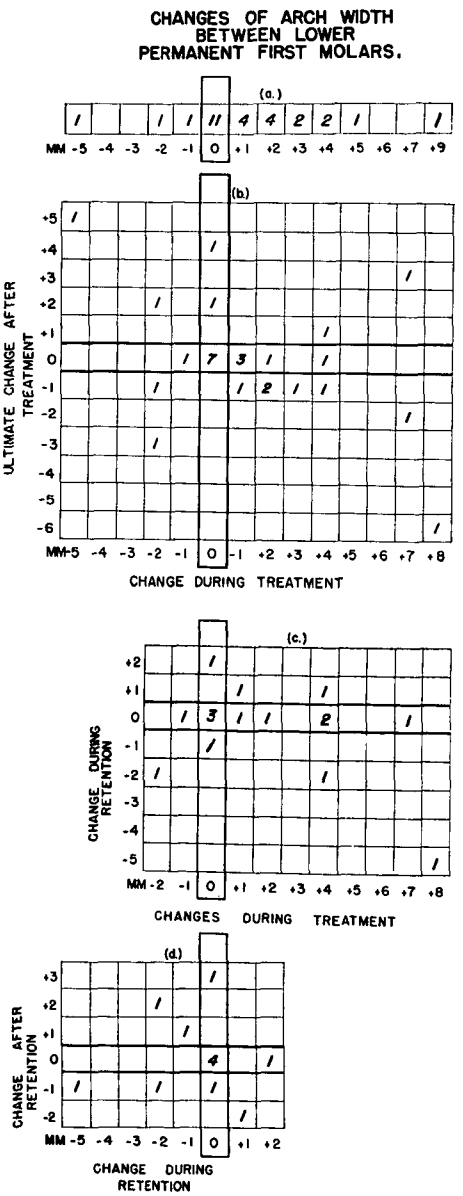

Fig. 2

Change Between the Lower First Permanent Molars

Generally speaking the distance changes between the lower molars is similar to that between the upper molars. *Figure 2 Chart (a),* the patient in the plus nine millimeter box presents the special situation in which one lower molar was tipped lingual to the upper molar before orthodontic treatment. During orthodontic treatment, Chart (b), the intermolar distance increased seven millimeters and ultimately following treatment this distance increased an additional three millimeters; this patient, (+3 +7), is registered in the extreme upper right quadrant (seven plus three is ten); however, the actual measurements are 6.7 mm plus 2.6 mm which equals 9.3 mm thus putting it in the 9 mm box. In Chart (c) this patient, (0, 7), shows the plus seven millimeter increase during treatment previously mentioned and no change during the period of retention. Chart (d) shows that although this patient (+3, 0), showed no change during retention, following retention the intermolar distance increased three millimeters. It should be mentioned here that in this same patient, simultaneously with the lower, the upper intermolar distance increased three millimeters during treatment, decreased two millimeters during retention, and then increased three millimeters following retention.

The changes in the lower intermolar distances are similar to those of the upper intermolar distances, *Figure 2, Chart (b).* There are two possible exceptions: one in the extreme lower

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right quadrant and the other in the extreme upper left quadrant. The patient in the lower right quadrant (—6, +8) had no crossbite and no bicuspids extracted. The distance between the lower molars increased eight millimeters during treatment as seen in Chart (c), decreased five millimeters during retention, and Chart (d) decreased an additional one millimeter following retention. Minus five millimeters and minus one equal minus six millimeters the ultimate change shown in Chart (b). Thus the increase recorded in Chart (a) minus six plus eight millimeters is only plus two millimeters. The other patient, in the extreme upper left quadrant, (+5, —5) Chart (b), had four bicuspids extracted. The lower intermolar distance decreased five millimeters during treatment, but increased the five millimeters following treatment, so is recorded in the zero box in Chart (a). Unfortunately this patient had no model to show the lower molar width during retention. It is evident that strong forces determine the lower intermolar distance, and if these forces do not change during the period of treatment, then they will restore the intermolar width to its original distance.

Finally it appears evident that, regardless of what change is or is not made in the upper and lower intermolar distances during the treatment period, the ultimate intermolar distance will be established according to the dictates of the balance of forces produced by the muscles, function, and growth of that particular individual.

Change Between the Upper Cuspids

Some of the patients whose intermolar changes have been recorded had cuspids not erupted fully, so those patients with unerupted or partially erupted cuspids are not included in

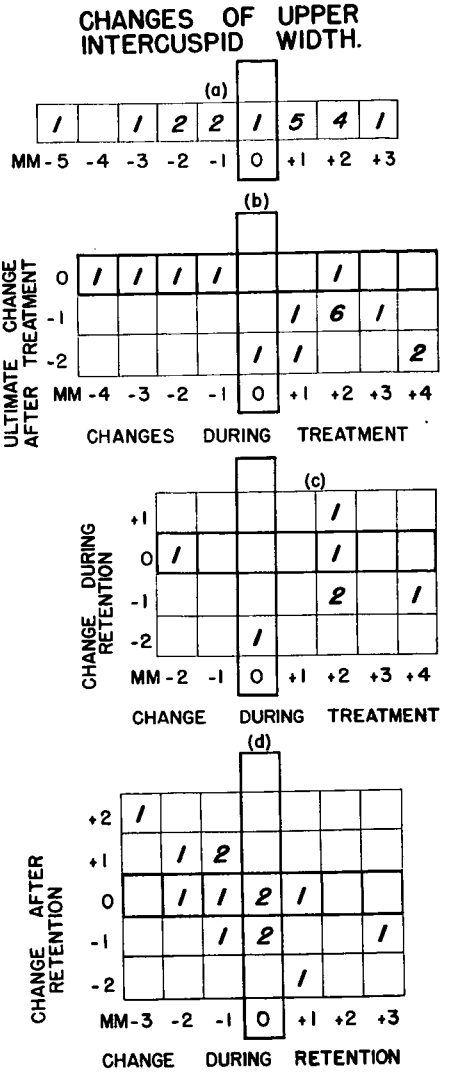

Fig. 3

Charts (a), (b), and (c). *Figure 3, Chart (a)* indicates that in only one patient did the distance between the upper cuspids not change ultimately from the original; all others either increased or decreased this distance.

Chart (b) shows that in each patient in which the intercuspid distance was increased or unchanged during the period of orthodontic treatment ("O" vertical column and to its right) this

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distance ultimately decreased except for one patient (0, +2) who stayed as treated; in no patient did this distance increase ultimately following the treatment period. In those patients in whom the distance was decreased during treatment (to left of "O" vertical column) this remained as decreased. The intercuspid distance did not increase ultimately in any patient following treatment, i.e., none recorded above the "O" horizontal column.

Change of Distance Between the Lower Cuspids

Figure 4, Chart (a). Many of the patients presented an increase or no change in the lower intercuspid distance from the original to the ultimate measurement; the greatest increase was six millimeters. A few, however, did show a decrease to as much as three millimeters.

Chart (b). Unlike the upper cuspids, in a few patients the intercuspid distance continued to increase ultimately (above "O" horizontal column) while others decreased slightly the distance established during the treatment period (below the "O" horizontal column).

The tendency in the treatment of the upper and lower intercuspid distances during treatment of some of the patients (lower right quadrant of Charts (b) Figures 3 and 4) was to make it too great during treatment and thus it decreased after treatment; none of the patients show the intercuspid distance decreased sufficiently during treatment to cause it to be increased following treatment (upper left quadrant). Nevertheless it must be borne in mind that Charts (a), Figures 3 and 4, show that most of the upper and lower cuspid distances do change from their original measurements.

Thus, like the upper and lower intermolar distances, the ultimate cuspid position or intercuspid distance is the result not necessarily of orthodontic treatment but of the balance of other forces produced by the musculature, function, and growth of each particular patient. If orthodontic treatment did produce a permanent change in any

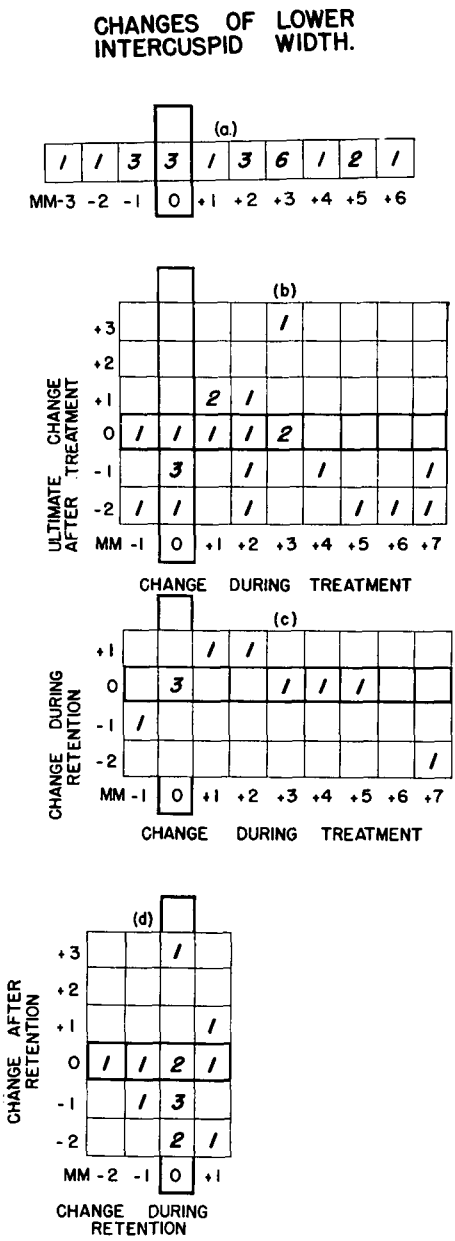

Fig. 4

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of these forces, the resulting ultimate tooth position would be nearer to that at the end of treatment.

Changes During the Retention Period

Some of the patients, but not all, had models made at the end of the retention period. These being available, the question arose as to what changes occurred during retention and thereafter; these are presented in Charts (c) and (d), even though the number of patients is consequently smaller. In Figure 1, Chart (c) the vertical columns show the changes during treatment and the horizontal columns the changes during retention, while in Chart (d) the vertical columns show the changes during retention and the horizontal columns the changes following retention. About half of the patients' upper intermolar distances stayed as treated ("O" horizontal column, Chart (c)) while the remainder either increased and decreased during retention the changes made during treatment (above or below the "O" horizontal column). In the lower right quadrant is one patient (−4, +5) whose intermolar distance increased five millimeters during treatment and then decreased four millimeters during retention. Thus it may be that retention of the distance between the upper molars was ineffective. Yet two other patients (−0, +5) had the intermolar distance increased five millimeters during treatment and it remained that way during retention. In four patients no change was made to the intermolar distance during treatment ("O" vertical column); one remained unchanged (0,0) and three increased the distance two millimeters during retention (+2, 0).

In Figure 1, Chart (d) about half of the patients showed no change following the period of retention ("O" horizontal column) while the remainder present either an increase or a decrease (above or below the "O" horizontal column) of the intermolar distance following retention.

Thus treatment and retention do not determine the ultimate upper intermolar distance in many patients.

In Figure 2, Charts (c) and (d), the changes in the intermolar distance of the lower molars are presented for the period of retention and thereafter. These changes are similar to those for the upper molars.

In Figure 3, Chart (c), there are but few patients recorded because of unerupted or partially erupted cuspids, but these present all types of change during retention. Following retention, Chart (d), the only patients that showed an increase in the upper intercuspid distance were those in whom this distance was decreased (upper left quadrant) during the period of retention; it is interesting that the increase is not greater than the decrease which occurred during retention. The remaining patients had no change ("O" horizontal column) or had a decrease in the intercuspid distance (below the "O" horizontal column) following retention. Thus the upper retainer seems to have had little if any effect upon these patients in maintaining the upper intercuspid distance.

Figure 4, Chart (c). During the retention period in all except one patient (−2, +7), the intercuspid distance remained within plus or minus one millimeter of that established during the treatment period ("O" horizontal column). This would seem to indicate that the fixed lower cuspid-to-cuspid retainer is effective.

Chart (d). Removal of the cuspid-to-cuspid retainer permitted the cuspids to move as desired, and some did change their intercuspid distances within a range from plus three millimeters to minus two millimeters. Thus, even

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though the cuspid-to-cuspid retainer is effective in maintaining the lower intercuspid distance, if this distance is not in balance with all of the other forces acting upon these lower cuspids, the cuspid will move to make this distance be in balance with such forces, regardless of the retention period.

The Effect of Bicuspid Extractions Upon Intermolar and Intercuspid Distances

The patients of this study were then divided into those who had bicuspids extracted and those who had not.

All of those patients who had bicuspids extracted showed a decrease from the original distance in the upper intermolar width ultimately (Figure 5). Only three patients without extractions showed a decrease while all of the others without extractions either remained unchanged or increased this distance ultimately.

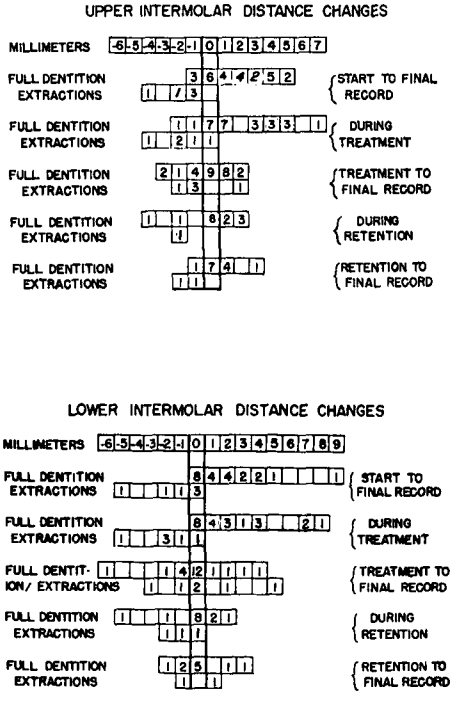

Fig. 5

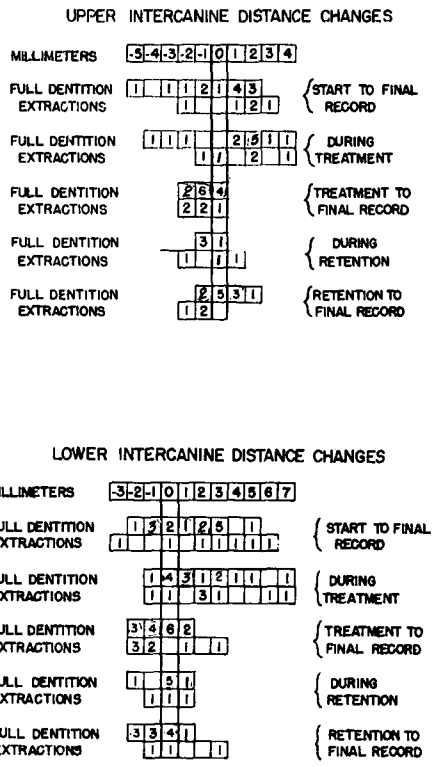

Fig. 6

The lower intermolar width changes (Figure 5) were similar to those of the upper except for three extraction patients who showed no change of intermolar width from before treatment to the ultimate model.

As to changes in the upper and lower intercuspid distances (Figure 6), those patients with extraction of bicuspids presented no discernible distinctive differences from the patients who had had no bicuspids extracted.

Thus extraction of bicuspids tends to decrease the upper and lower intermolar distances of the patients, but produces no discernible distinctive difference in the upper and lower intercuspid distances.

Conclusion

Orthodontic movement and retention of teeth produce lasting changes only

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in those particular patients whose forces, including the anterior component of force, acting upon the teeth have changed in such a manner during treatment (and retention) as to support those particular teeth in the newly acquired positions. The changes of these forces acting upon the teeth may be g.owth and development of bony, muscular, and nervous tissues, combined with newly-acquired functional and emotional habits. Orthodontic movement of teeth per se does not establish any tooth in its new position ultimately.

Application to Orthodontic Treatment

If the intermolar or intercuspid distances are made too great during treatment then the distances will decrease and this will cause crowding of the teeth. This crowding can be eliminated by keeping the intermolar and intercuspid distances to a minimum during the treatment.

While mechanics is of the utmost importance for controlled orthodontic tooth movement, the most important problems yet to be solved are (1) how to teach the patient to function in all ranges of motion, (2) how to teach the patient to overcome nervous or other emotional habits which produce his malocclusion, (3) how to better predetermine the amount, kind, direction, and time of growth yet to occur.

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