Cases Six Years Postretention

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Every orthodontist, ideally, develops a treatment plan that will produce a dentition in balance and in harmony which will remain stable over the years. Most orthodontists would agree that stability over a period of time is a good criterion for judging a successfully treated case. What are the keys and important factors that will help us attain this long-lasting stability of the dentition in orthodontically treated cases?

In an effort to delve into this problem, this investigation was undertaken. American Board cases were analyzed from a model analysis and a cephalometric analysis six years after any retention supervision.

Special goals for tooth placement which will produce stability have been the constant hope of many orthodontists. Angle[1] emphasized that stability cannot be hoped for unless an occlusion has been established that is in harmony as to the sizes and relationships of the dental arches. Brodie[2] enlarged on this theme of balance and harmony by indicating that the occlusion must also function in balance with the muscles during the physiological processes of speech, respiration, digestion and mastication.

Tweed[3] defined his parameters using the anterior limits of the denture in functional balance by measuring the FMIA angle, stating that unless the lower incisor was placed in a specific angular relationship, stability would be a problem.

Ricketts[4] also used the position of the lower incisor to determine the anterior limits of the denture. However, he used the position and angulation of the lower incisor in relation to the maxillae and the mandible.

Five factors are listed by Thurow that are necessary to produce a balanced and lasting dentition: 1) good treatment producing a good occlusion, 2) harmonious skeletal relationship, 3) favorable growth, 4) favorable functional environment, and 5) healthy periodontal relationships.[5] He also emphasizes that the lack of complete treatment, unanticipated growth, and habits that are not eliminated can be causes of many retention problems.

Boese[6] believes the following factors as being instrumental in causing failures in retention: 1) transeptal fibers not severed, 2) expansion of the cuspids, 3) unfavorable tooth relationships, 4) insufficient retention to allow principal fibers to reorganize, 5) post-treatment growth, 6) muscle tonicity and 7) habits.

Strang[7] emphasized that arch expansion would be a sure reason for retention relapse despite Walters'[8,9] findings that increases in mandibular cuspid width have been maintained for a considerable length of time. However, McCauley states that molar width and cuspid width might be established as fixed distances, and that the occlusion may be designed using those measurements.[10]

Riedel lists nine theorems that indicate the need for retention. He discusses the need for proper occlusion; that the lower incisor must be placed over the basal bone; bone and adjacent tissues must be allowed time to reorganize; and corrections carried out during growth are not as likely to relapse.[11] Riedel's last theorem is that arch form, particularly in the mandibular arch, cannot be permanently altered by appliance therapy.

The foregoing authors express many factors that contribute to stability or instability of orthodontic cases. This investigation was undertaken on a limited sample size to test the concepts of canine and molar width and how they affected arch length. An arch length analysis was made to determine the stability of the cases. A cephalometric analysis using Rocky Mountain Data Systems' norms and ranges at various ages was performed to compare our sample with theirs. The cephalometric analysis was also used to compare subgroups of my sample for any differences that might occur.

Material

The material consisted of eleven cases. Models and cephalometric headfilms were available at the following times: beginning of treatment (T1), average age 11.29 yrs., range 8.5 yrs. to 13.5 yrs.; end of treatment (T2), average age 13.9 yrs., range 11.8 yrs. to 16.5 yrs.; end of retention (T3), average age 17 yrs., range 14.8 yrs. to 19.4 yrs.; post retention (T4), average age 23.4 yrs., range 21.25 yrs. to 25.8 yrs.

The postretention records of all the cases in the sample were at least six years after any retention supervision. The sample consisted of one Class III, three Class I, and seven Class II malocclusions. The Class III malocclusion was treated without the extraction of teeth. Two of the Class I malocclusions and four of the Class II malocclusions were treated without extraction.

Method

All models were analyzed by making the following measurements:

1. Mandibular cuspid width, cuspid tip to cuspid tip.

2. Mandibular arch length, a piece of brass wire was adapted along the tips of the cusps and then measured.

3. Mandibular molar widths, anatomical points were chosen that could be seen on all models and measured using dividers.

4. Bolton analysis of anterior tooth size discrepancy performed by measuring the mesial-distal width of the mandibular and maxillary incisors.[12]

The cephalometric headfilms were analyzed by the Rocky Mountain Data Systems.[13] A comprehensive description of six different fields and 32 measurements were recorded. However, to limit the scope of the cephalometric analysis, only 13 measurements were studied for this paper. They were:

1. Incisor overjet, the distance between the incisal tips of the upper and lower incisors measured along the occlusal plane. The occlusal plane is the functional occlusal plane through the first molars and bicuspids (does not bisect the incisors).

2. Incisor overbite, the distance between the tips of the lower and upper incisors measured perpendicularly to the occlusal plane.

3. Lower incisor extrusion, the distance between the tips of the lower incisor and the occlusal plane.

4. Interincisal angle, the angle formed by the long axes of the central incisors.

5. Convexity, the distance between Point A and the facial plane.

6. Lower face height, the angle from anterior nasal spine to the center of the ramus (Xi) to pogonion. Xi point is chosen by making a rectangle of the ramus and is the center of the rectangle.

7. Mandibular incisor protrusion, the distance from the tip of the lower incisor to the APO plane.

8. Mandibular incisor inclination, the angle between the long axis of the lower incisor and the APO plane.

9. Occlusal plane to ramus, the distance between the occlusal plane and the center of the ramus (Xi). Positive numbers indicate the occlusal plane is

above the Xi point, negative below Xi point.

10. Occlusal plane inclination, the angle between the corpus axis and the occlusal plane (counterclockwise). Corpus axis, plane Xi point to pogonion.

11. Facial depth (Downs' facial angle), the angle between the facial plane and Frankfort plane.

12. Facial axis, the angle between the facial axis and basion-nasion plane. Facial axis is a line from PT to PO. PT is the junction of pterygopalatine fossa and foramen rotundum.

13. Mandibular plane measured to the Frankfort plane.

The cephalometric measurements were averaged at T^1, T^2, T^3, and T^4 to see if a difference could be detected between our sample and the Rocky Mountain data. Comparisons were also made between extraction and nonextraction samples, Class I and Class II samples, and between samples that at T^4 had 1-2 mm mandibular arch crowding and 3-4 mm of mandibular arch crowding.

Findings

The cuspid width in the entire sample from the start of treatment T^1 to T^4 decreased on an average of 1 mm. The largest increase was 1.5 mm and the largest decrease was 1.5 mm. The average time from T^1 to T^4 was 12.11 years. The cuspid width from the end of treatment T^2 to T^4, a 9.5 years age span, decreased .95 mm with a range from 0 mm to —2 mm. During treatment the cuspid width increased 0.3 mm with a range of 1.5 mm increase and 1.0 mm decrease.

The cuspid width has important clinical implications. Averages can be useful but they also can be restricting and mask individual variation. Because of this, the cases were analyzed individually. One of the cases was a Class III occlusion that started treatment at age 8.8 years T^1, finished treatment at age 11.1 T^2, and final records T^4 were taken at age 20.1 (Figs. 1 and 2). At T^4 the molars showed an excellent buccal occlusion with all third molars in occlusion and no more than 1 mm of lower arch crowding. The incisors were in an end to end relationship and the Bolton analysis showed an excess of 2.5 mm mandibular tooth size. The cuspid width was 26 mm at T^1 and 26.5 mm at T^4 indicating little or no change. The molar width showed the same constancy of 38.0 mm T^1 and 37.5 mm T^4.

The cephalometric analysis of this Class III showed a decreasing mandibular plane angle of 26.5° T^1 to 22.9° T^4. The facial axis was relatively constant 87.5° T^1 to 88.6 T^4 as was the convexity of 2.2 mm T^1 to 1.9 T^4. This case had a consistent growth pattern and remained stable for nine years after treatment.

Case R.B. (male) Class I, nonextraction (Fig. 3) had 3 to 4 mm of lower arch crowding at T^4. His cuspid width did not change from the end of treatment to the final models T^4, a total of 10.7 years. A latent growth spurt producing a Class III type molar occlusion was the probable cause of his lower arch crowding.

Case G.F. (male) Class I nonextraction (Fig. 4), had 4 mm of lower arch length crowding at T^4. At the beginning of treatment, there was no arch length discrepancy. The cuspid width was the same at the end of treatment T^2 and T^4, 8.75 years later. An increase of 1.5 mm occurring during treatment was maintained for 8.75 years even though there was some lower arch length decrease. The relapse was probably due to a latent growth period producing a Class III tendency.

Case T.C. (female) Class II, non-

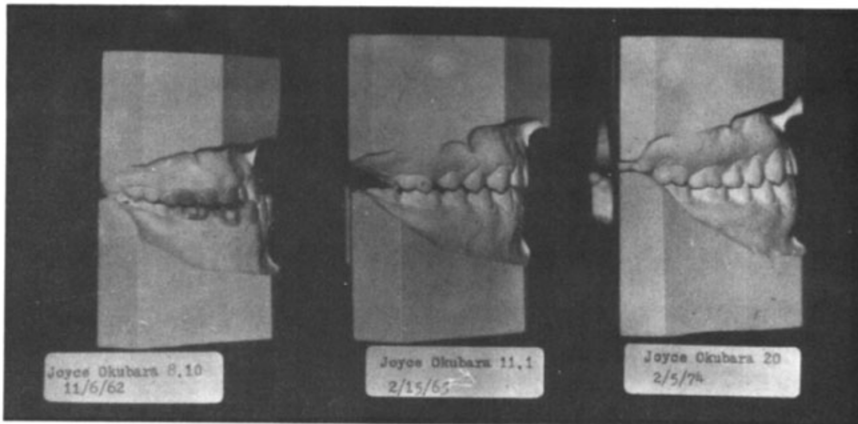

Fig. 1

Fig. 2

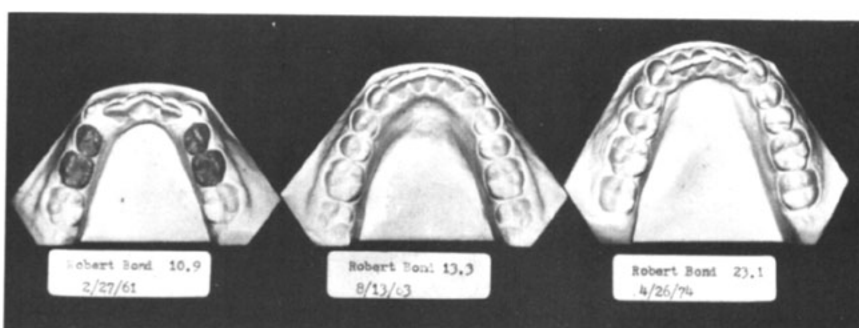

Fig. 3

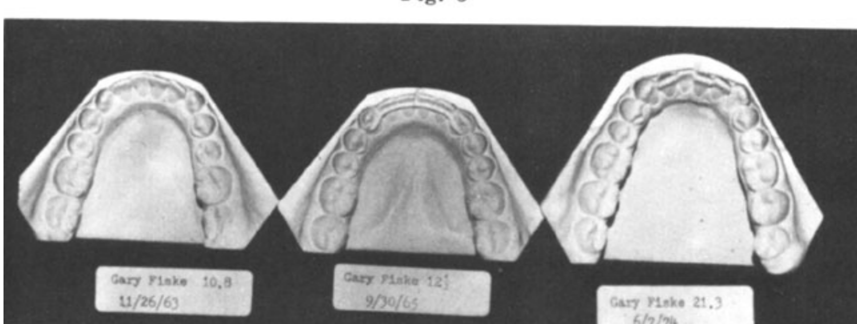

Fig. 4

extraction (Fig. 5), had 4 mm of lower arch crowding at T^4. Her cuspid width decreased 2 mm from the end of treatment to postretention 8.8 years later. The permanent cuspid width was not measurable at the start of treatment. A decrease in cuspid width probably contributed to lower arch crowding.

Case S.R. (male) Class II, extraction (Fig. 6), had 4 mm lower arch length crowding at T^4. A decrease of 2 mm in cuspid width occurred from T^2 to T^4. He had one mandibular lateral incisor extracted and still had cuspid width decrease in the posttreatment period. This case probably relapsed due to muscle, skeletal, and tooth relationships. At T^1 the lower incisor was behind the APO plane and remained there during treatment. Because of the skeletal convexity a high interincisal angle resulted. Due to the high interincisal angle and a strong muscle pattern, the bite closed and crowding occurred.

Case S.F. (female) Class II, nonextraction (Fig. 7), had 2 mm lower arch length crowding at T^4. A decrease of 1.5 mm in cuspid width occurred from the end of treatment to postretention, a period of 9.15 years. Deciduous cuspids were present at T^1 and were not measured. The lower arch relapse could be attributed to a decrease in cuspid width.

Case R.H. (male) Class II, nonextraction (Fig. 8) had 2 mm of lower arch length crowding T^4. The cuspid width decreased .5 mm from T^2-T^4, a period of 11.5 years. The cuspid width T^1-T^4 was identical. This case exhibited very little relapse and very little cuspid width change.

Case J.L. (female) Class II, extraction (Fig. 9) had 1 mm of lower arch length crowding T^4. The cuspid width was expanded 1.5 mm during treatment. The width decreased 1 mm from T^2-T^4, a period of 9.28 years. A slight (.5 mm) expansion was maintained and a very small amount of arch length crowding occurred.

Case J.M. (female) Class I, extraction (Fig. 10) had 2 mm lower arch crowding at T^4. The cuspid width decreased 1 mm during treatment. The cuspid width decreased another 1.5 mm from end of treatment T^2-T^4, a period of 9.74 years. Again, a slight decrease in arch length and a slight decrease in cuspid width.

Case E.O. (male) Class II, extraction (Fig. 11) had 1 mm of lower arch length crowding at T^4. The cuspid width was increased 0.5 mm during treatment, but was the same at T^4. A very stable case with the cuspid width identical at the beginning of treatment and at postretention, a period of 11.5 years.

Case D.P. (male) Class II, nonextraction (Fig. 12) had 1-2 mm of lower arch length crowding at T^4. A decrease in cuspid width of 2 mm from the end of treatment T^2-T^4, a period of 9.84 years. Beginning cuspid width not measurable due to deciduous cuspids being present. This case showed some cuspid width decrease and not much arch length change.

To determine what effect cuspid width had on lower arch crowding, the sample was divided into two groups. Group A (Figs. 2, 7-12), 7 cases, had 1-2 mm of lower arch length crowding at T^4 and Group B (Figs. 3-6), 4 cases, had 2-4 mm of lower arch length crowding at T^4. One half of the cases that had 2-4 mm crowding showed no change from the end of treatment T^2-T^4 and two cases had 2 mm of cuspid width decrease. The 1-2 mm crowding group all decreased slightly in cuspid width from T^2-T^4 ranging from .5 mm to 1.5 mm.

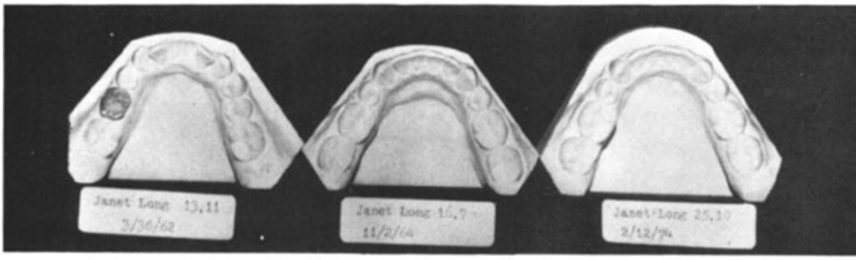

Fig. 9

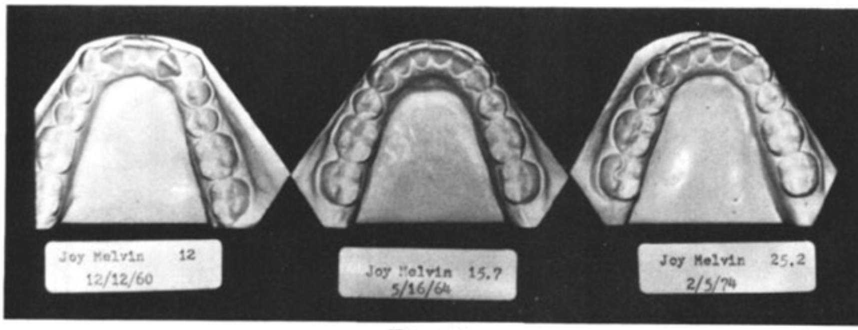

Fig. 10

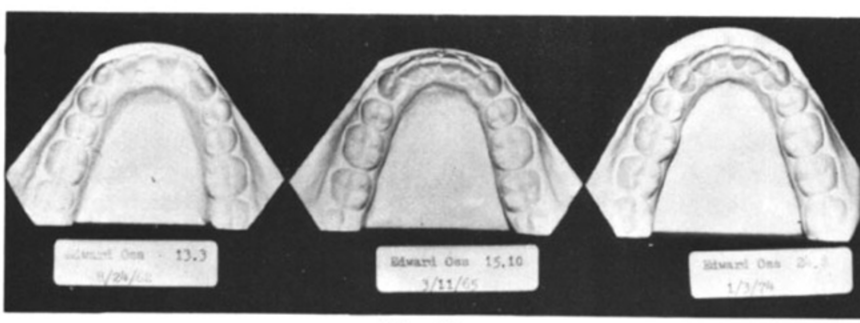

Fig. 11

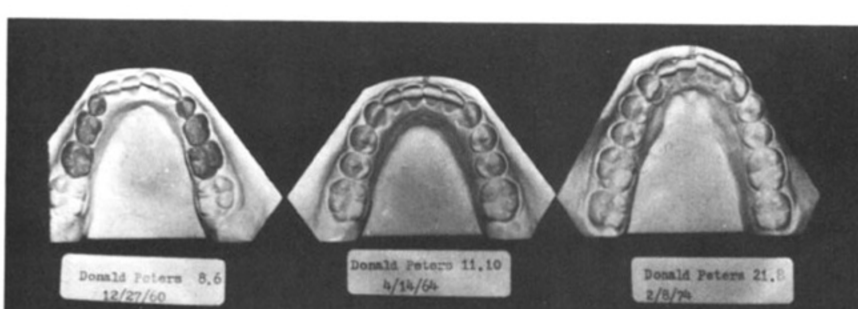

Fig. 12

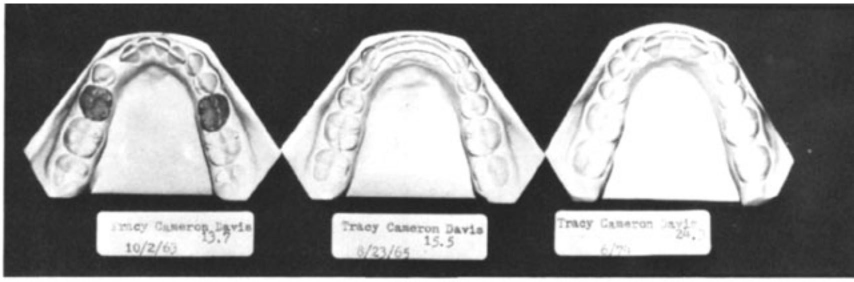

Fig. 5

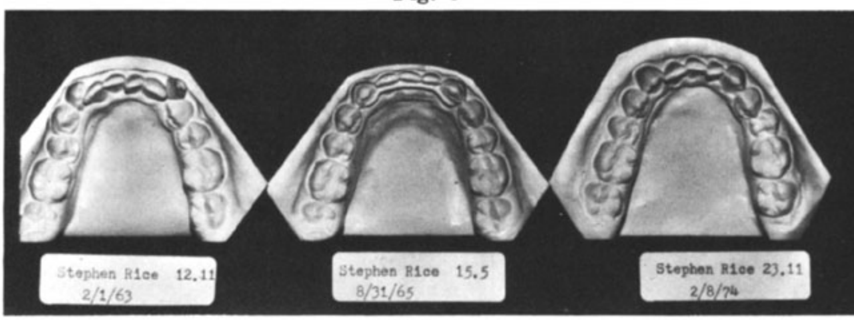

Fig. 6

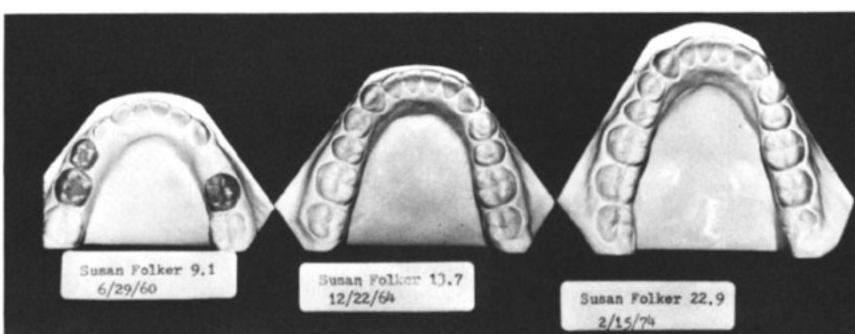

Fig. 7

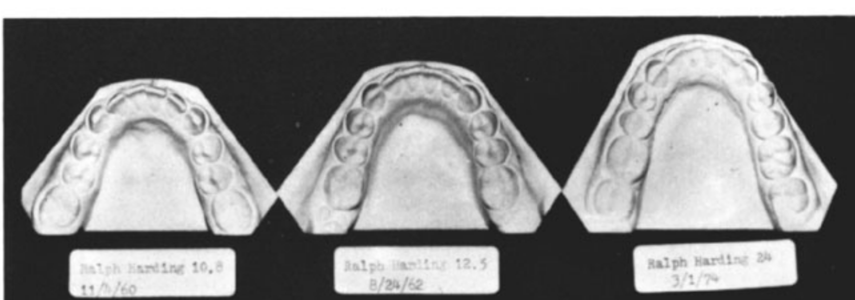

Fig. 8

These individual case analyses show that maintaining the cuspid width from the start of treatment through end of treatment may be an important factor in lower arch length stability. A latent growth period may be another factor that can cause lower arch length crowding, but is not predictable. The position of the incisors in relationship to each other and in relationship to the skeleton is another factor that can cause relapse and can be controlled to some extent. The maintenance of lower arch stability depends on a variety of variables other than cuspid width.

Mandibular arch length analysis showed four cases that had 2-4 mm of crowding at T^4. At the beginning of treatment one of these cases had no arch length problem, while two had only 1 mm or less deficiency. These three were treated nonextraction. The remaining case had 5 mm arch length shortage at T^1 and was treated by extraction. Seven cases had 2 mm of crowding at T^4, 9.5 years after treatment. Three were treated as extraction cases and four treated nonextraction.

The molar width of the entire sample showed a 0.8 mm increase from the beginning to the end of treatment, while the extraction group decreased 1.8 mm and the nonextraction cases increased 0.3 mm during this time. Both groups showed a decrease in molar width from T^1 to T^4 and from T^2 to T^4. The decrease in molar width could contribute to a loss of lower arch length. However, two cases that collapsed 3-4 mm had no decrease in molar width. Two cases having 2-4 mm of crowding had 1-2 mm of molar width decrease. No conclusion can be drawn from this finding.

The anterior Bolton analysis showed only five patients in the normal range of 74.5-80.4%. Five other cases showed an excess mandibular tooth width and one a maxillary tooth-size disharmony.

One case (Fig. 10) that measured an excess of 4 mm mandibular tooth size had a good result, as did another (Fig. 8) who had a mandibular excess of 2.6 mm.

The one case that measured a maxillary excess of 3 mm had one mandibular incisor extracted (Fig. 6). Omitting this case, one half of all cases measured an excess mandibular tooth size from 1.1 to 4.0 mm.

Only two cases which measured an excess mandibular tooth size had a clinical problem of anterior disharmony.

The reliability of the anterior Bolton analysis in this sample was not very specific as to which cases eventually would have a clinically apparent tooth-size disharmony.

As cephalometric tracings were made commercially a comparison was made between some of their tracings and the author's. Three cases were selected that had been traced by the author at T^1, T^2, and T^3. A comparison was made for: a) amount of convexity, b) the interincisal angle, and c) the position of the mandibular incisor in relation to the APO plane.

The comparison of convexity was very good; the greatest difference of any tracing was .6 mm. The lower incisor to the APO plane measurement showed that 89% had 1 mm or less in measuring differences. The interincisal angle measurement showed great variation between R.M. tracings and the author's, the largest difference being 17°. All headfilms for patients that had more than one S.D. or 6° difference in the interincisal angle were resubmitted for new tracings. The interincisal angle of one patient still remained outside one S.D. in comparing the tracings. The interincisal angle discrepancy may be due to difficulty in locating the apex and because of varying states of closure. Because of the variation and the

TABLE I

Analysis of entire sample except Class III

Sample Age	T1 11.67	T2 14.42	T3 17.92	T4 23.92	Rocky Mountain Norms T1	T2	T3	T4
1) Incisor Overjet	5.1*	2.1	2.3	2.6	2.5	2.5	2.5	2.5
2) Incisor Overbite	2.6	2.4	3.3	3.6	2.5	2.5	2.5	2.5
3) Lower Incisor Extrusion	1.9	1.1	1.2	1.6	1.3	1.3	1.3	1.3
4) Interincisal Angle	124.8	131.9	129.5	130.7	130.0	130.0	130.0	130.0
5) Convexity	4.2*	2.4	2.1	1.7	1.8	1.4	.3	0
6) Lower Facial Height	47.9	47.7	47.1	46.8	47.0	47.0	47.0	47.0
7) Mandibular Incisor Protrusion	2.3	2.3	2.4	2.4	1.0	1.0	1.0	1.0
8) Mandibular Incisor Inclination	23.4	24.2	26.3*	25.9*	22.0	22.0	22.0	22.0
9) Occlusal Plane-Ramus (XI)	0.9	-1.7	-2.2	-3.6	-0.5	-1.9	-3.6	-3.7
10) Occlusal Plane Inclination	25.0	26.7	27.0	27.7	24.0	25.4	27.1	27.2
11) Facial Depth	87.3	87.9	89.0	89.2	87.5	88.4	89.6	89.6
12) Facial Axis	89.6	89.6	90.7	91.0	90.0	90.0	90.0	90.0
13) Mandibular Plane (FH)	24.6	24.1	21.6	21.4	25.2	24.4	23.3	23.3

* one standard deviation

** two standard deviations

large differences in measurements, the interincisal angle measurements from a statistical analysis may not be too valid.

The entire sample excepting the Class III at beginning of treatment T^1 showed all values within the R.M. range except the overjet and the convexity measurements which were outside the range of one S.D. (Table I). At T^2, all values were within the normal range of the R.M. values. Two years after treatment T^3, all the values were within the normal range except the angle of the lower incisor which was labially inclined. At T^4 or at least 6 years after retention supervision, all values were still within the ranges used by Rocky Mountain Data Systems except the lower incisor inclination which was more labially inclined. The various measurements are summarized as follows:

1. The incisor overjet reduced during treatment to within normal range, stayed there for at least 9.5 years.

2. The incisor overbite deepened posttreatment about one mm in 9.5 years.

3. The lower incisor extrusion was relatively constant and the deepening of the bite was due to the extrusion of the maxillary incisors.

4. The interincisal angle, after treatment, was more upright indicating not enough torque, but at T^4, postretention, the interincisal angle was almost on the average.

5. The convexity was reduced during treatment to within the normal range and during the posttreatment period continued to decrease.

6. The lower face height was constant during treatment and during

growth. A good balance between the upper and lower face height may contribute to a stable overbite correction.

7. The lower incisor protrusion was slightly forward of the normal value at all times, but remained relatively constant.

8. The inclination of the lower incisor became more labial during the posttreatment period. This was an unexpected occurrence and is difficult to explain.

9. The behavior of the occlusal plane in relationship to Xi point followed the Rocky Mountain norms with the occlusal plane lowering in relationship to Xi point with maturation.

10. The occlusal plane diverges more with age in relationship to the corpus axis and the sample followed this pattern.

11. The facial depth (Downs' facial angle) increases with age. Again, our patients followed the norms at various ages.

12. The facial axis of 90° was a very consistent measurement at all times and ages. The greatest difference at any time was 1.2°.

13. The mandibular plane angle decreases with age according to Rocky Mountain Data on the average of .3 degrees each year. Again, this sample followed their ranges.

A comparison was also made between the averages of the nonextraction cases and the extraction sample. At T^1 the nonextraction patients showed all values within the normal range, while the extraction group had values outside the range of one S.D. of overjet, convexity and mandibular incisor protrusion. At the end of treatment T^2, the nonextraction group, was still within the normal range with the exception that the lower incisor was too procumbent and too labially inclined.

The extraction group at T^2 had more convexity, a higher interincisal angle, an opening of mandibular plane and a more divergent occlusal plane in comparison with R.M. ranges. Postretention 9.5 years later, the extraction group has all values within the normal range except convexity which is still outside the range of R.M. data. The nonextraction group at T^4 has values similar to the end of treatment, all within range except the position and inclination of the lower incisor.

The cephalometric comparisons would indicate that my nonextraction sample has a more procumbent dentition in relation to R.M. data averages.

A comparison of Class I cases and Class II cases showed the following differences: At the beginning of treatment the Class II cases exhibited more convexity, more overjet and a lower interincisal angle which were outside one S.D., while the Class I cases had only the lower incisor positioned labially and inclined labially outside the normal range. At the end of treatment T^2 the Class II cases had all values within the normal range, while the Class I cases still had the lower incisors which were protrusive and labially inclined. Postretention T^4 showed the Class I cases with a lowering of the occlusal plane and a more divergent occlusal plane to the corpus axis. The facial depth increased indicating late growth changes which could contribute to the crowding in this group.

The Class I sample contained two patients who had late growth changes resulting in a "Class IIIish" molar relationship. Both cases collapsed 3-4 mm at T^4 yet at T^1 there was no arch length shortage in one case. At T^1, skeletally, one case was convex and protrusive while the other case was flat and had a straight profile. Using the measurements studied, it would be most difficult to predict these late growth changes.

A comparison was made of the cases that had 1-2 mm (Group A, Figs. 2, 7-12) and 2-4 mm crowding (Group B, Figs. 3-6) at T^4. At T^1 Group A had normal range values for all measurements except convexity, overjet, and lower incisor protrusion which were outside one S.D. range. Group B at T^1 had all values within normal range except that the occlusal plane was too far above Xi point. At the end of treatment T^2, both Group A and B had all values within the normal range in comparison with Rocky Mountain. Postretention 9.5 years later, Group A had normal range values except far too much convexity and the lower incisor too labially inclined. Group B at T^4 had all values within normal range even though there was 2-4 mm of crowding.

Discussion

The cephalometric means and ranges with the age changes as advocated by Rocky Mountain Data Systems correlate with the measurements of this sample. Using the means with a range as an indicator of "normal face" seems justified. These mean values will indicate a facial structure that can have a good stable occlusion. The accuracy of the tracings and the range of values makes it impossible to define areas of measurements which could be the cause of little arch length crowding.

Many other factors such as muscle pressure and habits may contribute to posttreatment changes. If the buccal occlusion, the overbite, and overjet remain corrected, is a slight amount of lower arch crowding significant? A slight crowding might occur and still not affect the balance and harmony of the treated dentition.

Conclusions

1. The cuspid width is most likely to decrease after treatment (9 of 11) although on occasion a slight increase (2 of 11) was maintained.

2. The molar width is apt to decrease from the beginning of treatment through the postretention period.

3. The cephalometric measurements studied in this sample of good stable occlusions coincided with the norms and ranges as used by R.M.

4. The age changes of the various cephalometric measurements also agreed with the age changes that R.M. utilize.

5. Lower arch crowding may be due to multiple factors of expanded cuspids, protrusive and labially inclined mandibular incisors, and late skeletal growth changes.

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