Fiberotomy and Reproximation Without Lower Retention 9 Years in Retrospect: Part II

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The clinical applications and implications of circumferential supracrestal fiberotomy (CSF) and reproximation have already been discussed in Part I.[1] The purpose of this investigation was to evaluate the long-term clinical results of CSF and reproximation on crowded mandibular arches which were orthodontically treated but never retained, and observed from 4 to 9 years posttreatment. In addition, a periodontal assessment of those tissues associated with the fiberotomy and reproximation procedures was undertaken.

MATERIALS AND METHODS

The sample was comprised of initial, end of treatment, and posttreatment records of 40 patients with crowded mandibular arches which were orthodontically treated by extraction of premolars but never retained. There were ten males and thirty females whose average age at the end of active treatment was 14 years and 6 months. Eleven, twenty, seven and two were respectively 4 years, 5-6 years, 7-8 years and 9 years posttreatment. Intercanine width was used as a guide in treatment planning and original basic arch form was maintained as much as possible. All cases had CSF and reproximation performed to varying degrees. These cases were selected from records of private patients and were treated only by the author. A further breakdown in the distribution of patients can be seen in Table I.

	$\frac{4}{4}$ extraction	$\frac{5}{5}$ extraction	$\frac{4}{5}$ $\frac{5}{4}$ other extraction
Sample Size	18	16	6
Class I	14	8	3
Class II Division I	4	5	2
Class II Division 2	—	3	1

Table I Description of the sample.

Dental Casts

Initial, treatment complete, and posttreatment mandibular dental casts were taken of all patients and measurements were made utilizing a special dial caliper calibrated to 1/20 of a millimeter (Fig. 1).

A quantitative method of assessing mandibular anterior irregularity was used which was first reported by Little.[2] His scoring procedure involves measuring the linear displacement of anatomic contact points (as distinguished from the clinical contact points) of each mandibular incisor

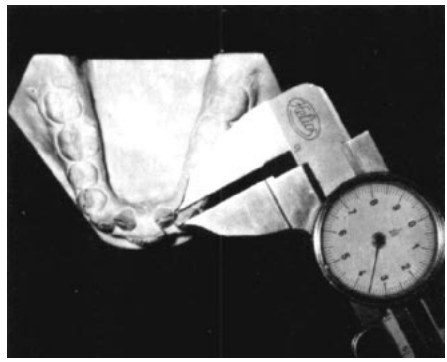

Fig. 1 Special dial caliper used to measure linear displacement of anatomic contact points.

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from the adjacent anatomic contact point, the sum of these five displacements representing the relative degree of anterior irregularity. Each case was ranked on a scale of 0 to 10 + as suggested by Little:

0	perfect alignment
1-3	minimal irregularity
4-6	moderate irregularity
7-9	severe irregularity
10 +	very severe irregularity.

Peck and Peck[3] reported a substantial relationship exists between mandibular incisor crown shape and the presence or absence of mandibular incisor crowding. They demonstrated that well-aligned mandibular central and lateral incisors have a remarkably distinctive crown shape as expressed by the mesiodistal/faciolingual index. The MD/FL index was used as a numerical expression of crown shape when viewed incisally and was confined to the mandibular incisors. It is constructed as follows:

$$\text{Index} = \frac{\text{(MD) crown diameter mm}}{\text{(FL) crown diameter mm}} \times 100$$

The mesiodistal contact points of the mandibular incisors were measured to determine the amount and time of reproximation.

The distance between the cusp tips of the mandibular canines was measured to determine the change in intercanine width.

Measurements were also made of overbite changes from occluded maxillary and mandibular casts. The amount of overlap of the upper central incisor was marked on the labial surface of the lower incisor. The measurements were calculated to the nearest 0.1 mm between the mark and the initial edge of the lower incisor.

Periodontal Assessment

Several methods were utilized in an attempt to assess the status of the periodontium. The depth of the gingival sulcus of the mandibular incisors was measured utilizing a periodontal probe. Intraoral Kodachrome photographs were taken before, after, and posttreatment of the periodontium associated with the lower incisors to document gingival color, contour, tone and texture. Clinical crown height was measured from mandibular casts to evaluate gingival recession.

Periapical Radiographs

An attempt was made to determine the level of alveolar bone at all three stages. This was felt to be extremely important since no previously published study has reported the long-term effects of fiberotomy and reproximation on the periodontium. The radiographs were exposed parallel to the long axes of the teeth to prevent elongation, foreshortening, and distortion. Since the technique is hardly precise, a measurement using the proportion of crown size to tooth length was performed to make the comparisons more meaningful. The numerical measurement is expressed as follows:

$$\frac{\text{alveolar crest to incisal edge (AI) mm}}{\text{tooth length (TL) mm}} \times 100 = \%$$ of tooth above alveolar crest

Cephalometric Assessment

Pretreatment, treatment complete, and posttreatment lateral cephalometric radiographs were made and the following measurements taken to evaluate mandibular incisal positions: interincisal, $\bar{1}$ to *NB* and *IMPA* angles; and linearly, $\bar{1}$ to *NB* and *APo*.

	Initial		Post Treatment 4 - 9 years	
	Mean(mm)	S.D.	Mean(mm)	S.D.
Irregularity Index	9.18	(2.87)	.62	(37)
MD/FL $\overline{2/2}$	99.1	(6.78)	92.7	(6.64)
MD/FL $\overline{1/1}$	96.4	(13.5)	91.02	(6.7)

Table II Means and standard deviations.

In addition, tracings were made of the cephalograms at the end of treatment and 4-9 years posttreatment to determine the direction and magnitude of posttreatment growth.

Findings

The initial, treatment complete, posttreatment mean changes and standard deviations were computed for irregularity index, MD/FL ratios, amount of reproximation, intercanine width, overbite, AI/TL ratios, and cephalometric measurements (Tables II, III and IV).

Irregularity Index

Tabulations of irregularity index scores point to the extreme stability of our sample. The mean irregularity index (I.I.) before treatment was 9.18 with a standard deviation of 2.87; the mean I.I. posttreatment was only .62 with a S.D. of .37. Figure 2 shows the degree of irregularity in eleven of the most crowded cases and subsequent minor change during the posttreatment period. It should be noted that Little considers a score of 7-9 to be severely irregular and a score of 10+ very severely irregular.

MD/FL index

The mean MD/FL index at the start of treatment for the mandibular lateral incisors was 99.1%, S.D. 6.78, while the mean or MD/FL for the original central incisors was 96.4%, S.D. 13.5. Reproximation markedly reduced the previous unfavorable

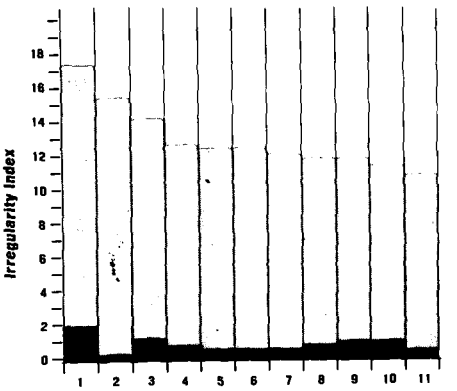

Fig. 2 Comparison of Irregularity Indices of the eleven most severely crowded cases. Gray portion of vertical bar represents the original degree of irregularity in the lower incisor area before treatment, while black portion shows the amount of irregularity which returned during the posttreatment period.

MD/FL ratios, the posttreatment mean MD/FL for the mandibular lateral incisors was 92.7%, S.D. 6.64, while the posttreatment mean for the mandibular central incisors was 91.02%, S.D. 6.7. According to standards recommended by Peck and Peck, ideally shaped lower centrals have a MD/FL index 88-92% and the lower laterals recommended range is 90-95%.

Reproximation

The amount of stripping accomplished during Phase I (initial incisor alignment and Phase II (four to six months postband removal) was determined by measuring the mesiodistal widths of the lower incisors at the completion of treatment and comparing them to the incisors at the start of treatment. The mean value for reproximation of lower incisors at the completion of treatment (Phases I and II) was 1.69 mm with a S.D. of .64. In our sample of 40 cases, apparently 61.5% of all reproximation was done during Phases I and II, with the remaining being performed some

	Initial		Treatment Complete		Post Treatment 4 - 9 years	
	Mean(mm)	S.D.	Mean(mm)	S.D.	Mean(mm)	S.D.
Reproximation			1.04	(.57)	1.69	(.64)
Intercanine Width	24.8	(2.02)	25.6	(1.51)	24.4	(1.68)
Overbite	3.72	(1.83)	3.13	(.73)	3.26	(.79)
AI/TL	37.3	(3.92)	38.3	(3.35)	37.84	(5.64)

Table III Means and standard deviations.

time later in the posttreatment period (Phase III).

Intercanine Width

The original intercanine width mean was 24.82 mm, S.D. 2.02. The mean width at the completion of treatment was 25.67 mm, S.D. 1.51, resulting in .85 mm of intercanine expansion. As one might expect, the intercanine width decreased during the posttreatment period to 24.4 mm, S.D. 1.68. This mean showed 1.27 mm reduction in intercanine width from the time treatment was complete to the time posttreatment records were taken. The mean posttreatment width was only .42 mm smaller than the original intercanine width. While the majority of posttreatment widths closely resembled the originals, four cases showed expansion of 2-5 mm and seven cases had a reduction of 2-3.5 mm (Fig. 3).

Overbite

The mean overbite which existed prior to treatment was 3.72 mm, S.D. 1.83. It decreased at the completion of treatment to a mean of 3.13, S.D. .73 and deepened only slightly during the posttreatment period to a mean of 3.26 mm and a S.D. of .79.

Periodontium

Periodontal probing the gingival sulcus of mandibular incisors on posttreatment patients revealed minimum pocket depths ranging from .5 to 1.5 mm. In 40 cases, two patients had some evidence of periodontal

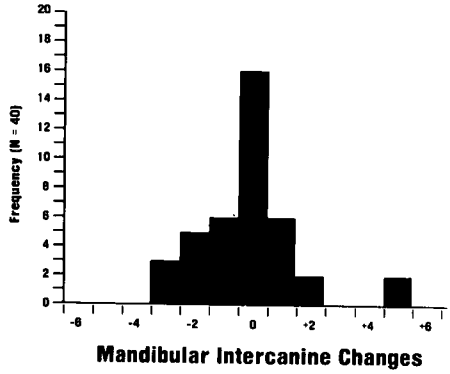

Fig. 3 Histogram illustrating frequency distribution of changes in mandibular intercanine width (mm) observed posttreatment.

disease. One exhibited 2-2.5 mm gingival pockets with an associated chronic generalized gingivitis but no apparent bone loss; the second patient exhibited signs of chronic periodontitis with 3-4 mm periodontal pockets and some radiologic evidence of alveolar crestal bone loss. This particular patient had signs of periodontal disease prior to orthodontic therapy and had extremely poor oral hygiene throughout treatment. Posttreatment Kodachrome slides of the periodontium associated with the mandibular incisors verified the clinical impression that the periodontium in 38 of 40 patients was well within normal limits as evidenced by the color, tone, morphology and texture.

Rating the amount of gingival recession from diagnostic casts presented some difficulty. Frequently, the mandibular canines were not completely erupted or prevented from full eruption due to crowding or partial impaction; in certain cases, hypertrophic tissue partially obscured the normal clinical crown. If these two factors are discounted, there appeared to be no clinically significant gingival recession (less than 1 mm) involving the labial aspect of the mandibular incisors. Some recession was

observed on the labial of mandibular canines but it was not a general finding and usually occurred unilaterally. Recession appeared to be consistently associated with those canines having extremely thin labial cortical bone and little attached gingiva before treatment (these areas were never surgerized).

Periapical Radiographs

The mean value calculated from the original periapical X-rays of $\frac{AI}{TL}$ was 37.3%, S.D. 3.92; the $\frac{AI}{TL}$ mean calculated from radiographs at the end of active treatment was 38.34%, S.D. 3.35, and the mean taken from 4-9 years posttreatment was 37.84%, S.D. 5.64. Although one should not place undue emphasis on an arithmetical relationship produced by a technique which is far from precise, all three means were extremely close. It was also interesting to note that not one carious lesion or restoration was evident in any radiographs taken on our sample of 40 patients in spite of our reproximation procedures.

Cephalometric Values

The mean values and standard deviations for all tooth relationships measured from cephalometric head films can be found in Table IV. Comparison of treatment complete with posttreatment tracings produced some interesting findings. In our 40 patients, 20 grew after treatment and 20 did not. Sixteen experienced mainly horizontal mandibular growth which is commonly observed during the terminal phase[4-6] while 4 grew vertically. It is important to realize that 19 cases of 40 required more than 1.8 mm of reproximation, 10 experienced posttreatment growth and 9 did not. Surprisingly, 8 of the 9 nongrowing patients required significant amounts of reproximation during the Phase III time period.

	Initial		Treatment Complete		Post Treatment	
	Mean (mm)	S.D.	Mean(mm)	S.D.	Mean(mm)	S.D.
1/ 1/	130.7°	(10.2)	136.8°	(8.16)	139°	(8.14)
1/ to NB°	23.3°	(5.25)	20.8°	(4.43)	19.2°	(5.01)
1/ to NBmm	4.58	(2.15)	3.11	(1.86)	3.07	(1.96)
IMPA	92.1°	(5.18)	89.5°	(5.47)	88.6°	(5.23)
1/ to AP	1.87	(1.52)	.69	(1.09)	.30	(.67)

Table IV Cephalometric means and standard deviations.

Discussion

Observation of mandibular arches which had never been retained and observed 4-9 years after treatment provided dramatic evidence of stability in the mandibular anterior segment. This was reflected in the mean Irregularity Index of 9.18, S.D. 2.87 before treatment compared with a mean Irregularity Index of .62, S.D. .37 posttreatment (Fig. 2). Severe rotations which were present originally had not relapsed during the posttreatment period in contrast to other rotation studies[7] where CSF was not used (Figs. 4, 5, 6 and 7). Even those cases having marked bodily tooth displacement demonstrated exceptional stability which was confirmed by low posttreatment I.I. scores (Figs. 4 and 5).

Most pretreatment incisors had extremely poor crown shapes based on the standards of Peck and Peck; the mean MD/FL Index for mandibular laterals was 99.1 and the mandibular centrals had a mean of 96.4 After reproximation, the MD/FL ratios were reduced to a more acceptable range with a mean of 92.7 for laterals and 91.02 for centrals. The findings of this study strongly support the contention of Peck and Peck that well-aligned mandibular incisors have a remark-

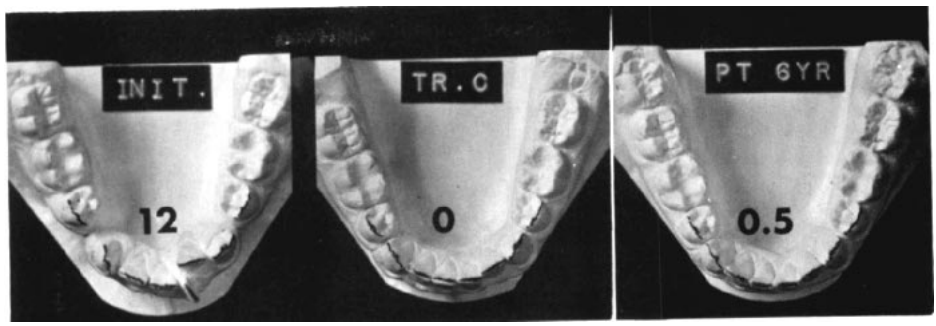

Fig. 4 Initial model on left has I.I. of 12, shows severely rotated left central incisor and lingually displaced left lateral incisor. Center model is treatment complete. Model on right is 6 years posttreatment with I.I. of 0.5. Note stability of previously rotated left central incisor.

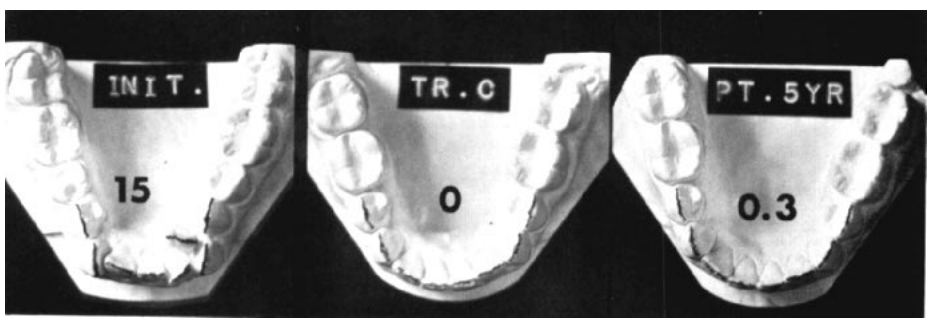

Fig. 5 Initial model on left with I.I. of 15 displays rotations and severe lingual displacement of left lateral incisor. Center model shows treatment complete with ideal positioning of left lateral incisor obtained by gaining bodily tooth movement utilizing proper labial root torque. Model on right is 5 years posttreatment with I.I. of 0.3. Note stability of left lateral.

ably distinctive crown shape as expressed by the MD/FL Index. The amount of tooth structure reduced in this study was far from excessive as demonstrated by the posttreatment reproximation mean of 1.69 mm.

However, the importance of reproximation in providing both additional space in the lower anterior segment and broad lower incisor contact point areas can not be overemphasized. Space enabled us to work within the confines of original arch form, particularly in the mandibular anterior segment which is most resistant to any significant expansion postretention. The broad contact points provide a mechanical buttress resisting the forces generated during terminal phases of mandibular growth. Since we did not use retention, the lower incisor segment was able to move and posttreatment changes did occur, but incisors tended to move as a unit rather than as individual teeth. If the lower incisor contacts are poorly defined, they are more easily influenced by any distal vector of force acting upon them.

Obviously, each clinician should realize that reproximation must be applied judiciously and precisely. The mesiodistal reduction of a tooth structure is easily accomplished; unfortunately, without sufficient forethought it is even easier to change a poorly-shaped incisor into a mutilated one. While the clinical applica-

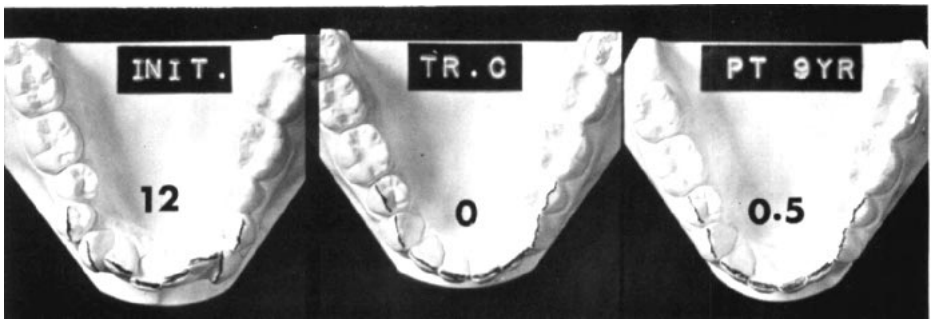

Fig. 6 Initial model on left with I.I. of 12. Center model is treatment complete. Model on right is 9 years posttreatment with I.I. of 0.5.

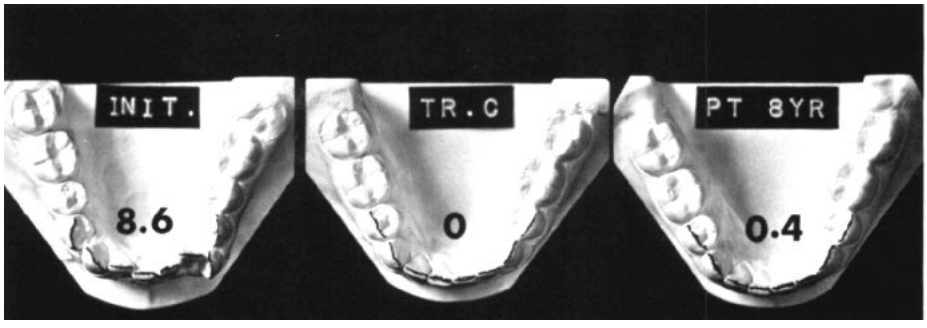

Fig. 7 Initial model on left with I.I. of 8.6. Center model is treatment complete. Model on right is 8 years posttreatment with I.I. of 0.4.

tions and implications of CSF are well-defined and simply performed, those of reproximation are much more complex since they act over long periods of time and are not reversible.

The behavior of mandibular intercanine width was predictable in that it generally tended to return to its original dimension with a mean decrease of only .42 mm (Fig. 3). Although 29 cases responded as one might expect, 11 did not. Four of the 11 cases showed 2-5 mm of expansion after 5 years posttreatment and 7 cases showed a 2-3.5 mm reduction of intercanine width 4-7 years posttreatment. Close examination of these 11 cases revealed a striking similarity, atypical canine position which did not relate to the general arch form in the mandibular anterior segment. The expansion cases had canines which were markedly constricted toward the lingual (Fig. 8). The seven cases which experienced a significant loss of width had lower canines which were positioned labially and were well outside the general arch form dictated by the alveolar process of the mandibular anterior segment.

While maintenance of original intercanine width appeared to be a useful guide in treatment planning, maintenance of original arch form was the rule especially in the mandibular anterior segment.

One of the primary purposes of this study was to investigate the long-term effects of CSF and reproximation on the periodontal tissues in the mandibular anterior area. Clinical examination with a periodontal probe revealed gingival tissue with

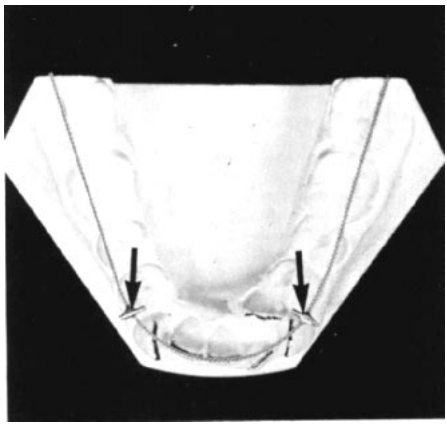

Fig. 8 Arrows point to positions of mandibular canine tips at the completion of treatment. The wire jig was taken from treatment complete model and is superimposed over the original mandibular model. This extraction case maintained 5 mm of intercanine width expansion 5 years after treatment. Notice original arch form and the blocked out position of the canines.

minimum pocket depth which appeared to be well within normal limits. Personal inspection and Kodachrome photographs showed the tissues to have normal color, good morphology, and possess normal stippling. There was no evidence of generalized gingival recession on any of the mandibular incisors and the recession that did occur in some canine areas was always located on labial sites associated with thin cortical bone and little attached gingiva. CSF was never performed on the midportion of the labial gingiva of any lower incisor or canine.

The question of whether reproximation causes loss of interdental bone in the lower incisor areas was best answered by the posttreatment periapical radiographs. A comparison of initial, treatment complete, and posttreatment periapical radiographs of lower incisors, all of which had some degree of reproximation, showed no significant decrease in alveolar crestal height or loss of interdental bone (Fig. 9). The $\frac{AI}{TL}$ ratios were all very close. Based on these findings, one can only assume that the magnitude of reproximation which was performed (mean 1.69 mm, S.D. .64) did not result in any measurable alveolar bone loss.

Analysis of the cephalometric measurements showed that the lower incisor moved in a predictable manner. Since all 40 patients were extraction cases with a significant degree of crowding, one would expect to see only a moderate degree of lower incisor retraction. The lower incisor moved lingually during treatment and continued to upright during the posttreatment period. Posttreatment growth occurred in 20 patients, 16 individuals experienced primarily horizontal mandibular growth, while 4 displayed a vertical pattern. Additional amounts of reproximation appeared to be necessary in patients who experienced a marked degree of horizontal growth. This would agree with the work of Siatokowski,[4] Schudy,[5] and DeKock[8] who described the uprighting of the lower arch and subsequent secondary lower incisor crowding which results when a horizontally growing mandible meets the forward resistance of the upper incisors which are confined within a nongrowing or slower growing maxilla. The distal vector of force directed against the lower incisors during periods of marked horizontal growth will cause an increase in contact point pressure which can easily be assessed using dental floss. Reproximation appears to dissipate the force by creating sufficient space to allow for some distal tooth movement.

Finally, the practice of not using any lower retention played a critical

role in the stabilization of the lower anterior segment. Lower retention eliminates the need for reproximation, since it postpones natural arch-length loss, prevents any compensatory lower incisor movement, and allows for a build up of forces during the retention period. The decision not to use lower retention will allow for natural arch length loss which occurs gradually and can be dealt with immediately. Many authors state that fixed retention should be continued until all growth has been completed to prevent secondary crowding of the lower incisors; this implies that growth is the major factor in post-treatment crowding. It should be noted that of the 19 cases which required the most reproximation, 9 were nongrowers; obviously the denture adjustment which was made possible by reproximation without retention was not dictated by mandibular growth.

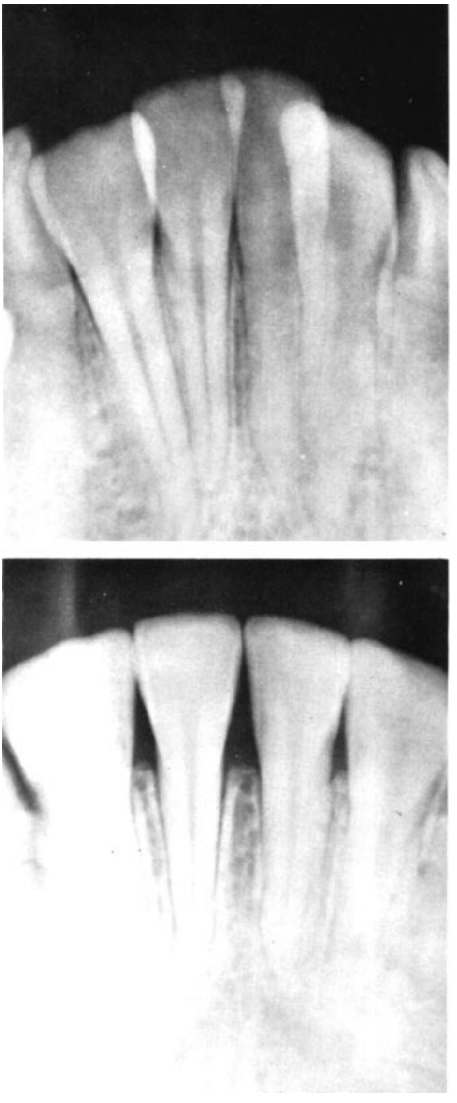

Fig. 9

Above, initial periapical radiograph of severely crowded unfavorably shaped lower incisors. Notice congested root area with thin zone of interradicular bone between the central and lateral incisors.

Below, periapical radiograph of same lower incisor area 8 years posttreatment. Note improved lower incisor shape because of reproximation, the wider area of interradicular bone, and the normal appearance of the alveolar crestal bone.

Summary and Conclusion

This study demonstrated marked stability of the mandibular anterior segment 4-9 years posttreatment which did not result from a refinement of orthodontic mechanics, but rather evolved from better understanding the biology of that area. Now we recognize the influence of displaced supra-alveolar connective tissue fibers associated with rotated teeth, and appreciate the importance of favorably-shaped lower incisors in resisting posttreatment changes. As a result the clinician can readily accept the concept of circumferential supracrestal fiberotomy (CSF) which severs displaced connective tissue fibers and can employ reproximation which provides space and broad contact-point areas, thereby placing the mandibular anterior segment more in harmony with the original arch form. If one routinely employs the concepts of CSF and reproximation on crowded man-

dibular arches, the choice of not utilizing mandibular retention is most logical and less frightening.

Based on the clinical findings of this study, the following conclusions were made:

1. Circumferential supracrestal fiberotomy (CSF) produced long-term stability of previously rotated teeth which were corrected orthodontically.

2. A slight overcorrection of tooth rotations should be accomplished at least six months prior to CSF to insure normal contact point relationships and principal fiber realignment.

3. Reproximation, precisely and conservatively performed, increased the long-term stability of the mandibular anterior segment.

4. The majority of all reproximation is performed early in treatment and within six months of band removal if no lower retention is employed.

5. Serial reproximation during the posttreatment period is often necessary, especially on patients experiencing marked horizontal growth or where lower arch form has been significantly altered especially in the mandibular incisor-canine areas.

6. The periodontium of those teeth which underwent CSF and reproximation displayed no significant increase in pocket depth, gingival recession, or loss of alveolar crestal bone, 4-9 years after treatment.

7. The practice of not utilizing mandibular retention played an integral part in stabilizing the lower anterior segment.

Finally, we can not look upon circumferential supracrestal fiberotomy and reproximation as a panacea for all our treatment problems, but rather as an embellishment of sound orthodontic treatment principles and good orthodontic therapy. The use of CSF and reproximation should not be accepted as a guarantee for permanent ideal lower anterior tooth alignment, but perceived as a useful process which appears to work within a framework of natural changes that inevitably will occur.

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