

The Effect of Orthodontic Treatment on the Periodontium

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During the past two decades the relationship of plaque to periodontal disease has been thoroughly researched and reported in the dental literature.¹⁻⁸ During this same period very little attention has been focused on the relationship of orthodontic treatment to periodontal disease,⁹⁻¹⁰ or on the relationship of orthodontic treatment plus plaque to periodontal disease. By comparing the debris on the teeth to the periodontal involvement on orthodontic patients this paper will explore the effect of full-mouth orthodontic procedures on the periodontal tissues.

MATERIAL

The information for this study was gathered from fifty consecutively-treated orthodontic patients. All patients except one were treated using full maxillary and mandibular edgewise appliances. The one exception had treatment of only the maxillary teeth. Twenty-three were boys and twenty-seven were girls. The age range at the beginning of treatment for the boys was twelve to seventeen years with an average of thirteen years five months. The average length of treatment for the boys was seventeen months with a range of nine to twenty-four months. The average age of the girls at the beginning of treatment was thirteen years one month with a range of eleven to sixteen years of age. The average duration of treatment was sixteen months with a range of nine to twenty months. Of the fifty cases studied, thirty-three were

treated without extraction of teeth. The seventeen extraction cases had four premolar teeth removed. To the best of our knowledge, none of the patients were taking any medication which would result in any changes of the gingiva nor were any of the patients suffering from any systemic ailment or deficiency which would manifest itself in gingival changes.

METHODS

One to two weeks prior to placing orthodontic appliances, each patient was given a periodontal examination. This examination was repeated every three months during treatment. At the time the appliances were removed, the teeth were cleaned with an ultrasonic instrument and forty-eight hours later the examination was repeated prior to placing retainers. A final examination was given four months later. The retention appliances used consisted of a maxillary Hawley retainer and either a mandibular fixed retainer or a mandibular Hawley-type retainer.

Routine home care instructions were given to all patients. They were told to brush their teeth after each meal. Several types of tooth brushes were made available to them. In cases where it was evident that the patient's brushing technique was inadequate, special brushing instructions were given. In cases of neglect the parents were informed by letter and, if written communication produced no better results, a conference with patient and parent was arranged to stress the importance of good oral hygiene. These measures were usually successful in obtaining an

Presented at the January 1973 meeting of the Midwestern Component of the Angle Society.

adequate degree of oral hygiene, but in some instances all attempts to instruct and motivate the patient in good oral-hygienic practices failed completely.

During the initial examination an assessment was made of the type of bony architecture present,¹¹ for example, whether it was thick, thin, average, or a combination of these. A set of full-mouth intraoral periapical radiographs or a panoramic radiograph was taken prior to treatment and after the completion of treatment.

At each examination the following procedures were carried out: 1) Frontal, right and left intraoral Kodachrome photographs were taken. 2) The depth of gingival sulcus was measured to the closest millimeter at six positions on each tooth in the mouth, at the mesial, in the center of the crown, and at the distal on both the lingual and facial surfaces. Measurements were made with a Michigan periodontal probe. A notation on the sulcus depth chart was made for each area where the sulcus was four millimeters or greater in depth. 3) The length of the clinical crown on the facial surface from cusp tip or incisal edge to gingival margin was measured to the closest one-half millimeter for the maxillary and mandibular first molars, first premolars (unless missing in which case second premolars were measured) and central incisors. The measurements on the molar teeth were made at the mesiobuccal cusp. 4) Russell's system of classification¹² and scoring of periodontal disease was determined at each examination. 5) The oral debris index described by Greene and Vermillion¹³ was determined (at each examination) after staining the teeth with basic fuchsin disclosing solution. 6) A frontal view intraoral Kodachrome photograph was taken to record the extent of staining on the teeth by the disclosing solution.

RESULTS

Radiographic Findings

The pre- and postoperative radiographs showed no areas of alveolar crest pathology in any of the subjects. This supports the work of Marshall Day¹⁴ who reported in 1956 that the incidence of alveolar crest pathology was negligible in the range of thirteen to fifteen years.

Depth of Gingival Sulcus

The depth of the gingival sulcus was measured at six areas on each tooth which would amount to one hundred and sixty-eight measurements if twenty-eight teeth were present. If the sulcus depth was four millimeters or greater, this was recorded on the periodontal depth chart; if the sulcus was less than four millimeters in depth, nothing was recorded. Four millimeters was selected because at this depth inflammatory changes are usually noted at the bottom of the sulcus when studied histologically. Since no bone loss was demonstrated radiographically, increase in sulcus depth can then be classified as gingival hyperplasia.

The number of areas where the sulcus was four millimeters or more in depth varied greatly, not only among different individuals, but also in the same individual at different times. There was a consistent ratio, however, of one to four hyperplastic areas at the midcoronal position versus the mesial or distal position. In other words, there were four times as many hyperplastic areas interproximally than at the center of the crown. There were also five times as many hyperplastic areas recorded for the premolar and molar teeth as there were for the incisor and canine teeth.

Before orthodontic treatment there was a total of 176 areas where tissue hyperplasia resulted in a sulcus depth of four millimeters or greater. Most areas were four millimeters in depth,

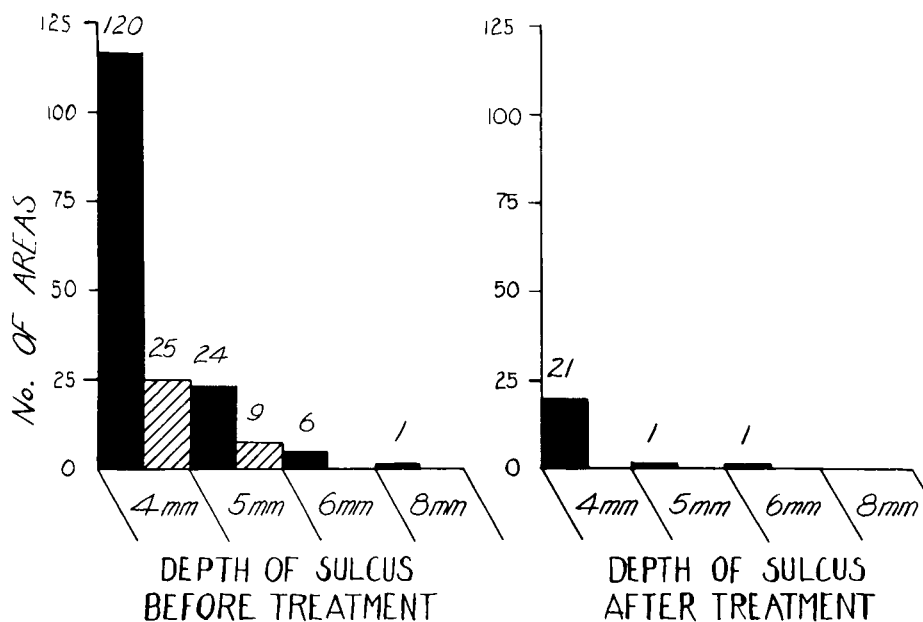


Fig. 1 Depth of the gingival sulcus before and after orthodontic treatment. posterior teeth; anterior teeth.

but some were five and six millimeters with one eight millimeter sulcus being found. The bulk of these were in the posterior part of the mouth. Following orthodontic treatment, the number of hyperplastic areas resulting in a deepened sulcus was reduced to 28 with none in the anterior area, and only two being over four millimeters in depth in the posterior area, one five millimeter sulcus and one six millimeter sulcus (Fig. 1).

Length of Clinical Crown

The lengths of the clinical crowns were measured on each patient for twelve teeth: the first molars, first premolars and central incisors. These recordings were taken at the center of the crowns for the incisors and premolars and at the mesial-buccal cusps for the first molars. Slight variations in crown length, mostly in the magnitude of one-half millimeter, occurred from time to time during treatment depend-

ing on the amount of inflammation present. More significant, however, were changes which occurred between the first examination prior to placing appliances and the last examination made four months after removal of the appliances. When comparing the changes in clinical crown length over this span of time and orthodontic treatment, there were no changes at all in 82% of the measurements. Clinical crowns increased in length 1 millimeter in 6.6% of the measurements, 2% increased 1.5 millimeters and .8% increased 2 millimeters for a total of 9.4% of the teeth measured. Clinical crowns decreased in length 1 millimeter in 7.8% of the measurements and .8% decreased 1.5 millimeters for a total of 8.6% (Fig. 2). Statistically, using a Poisson distribution, there was not a sufficient number of increases in crown lengths to make treatment responsible at the .05 probability level.

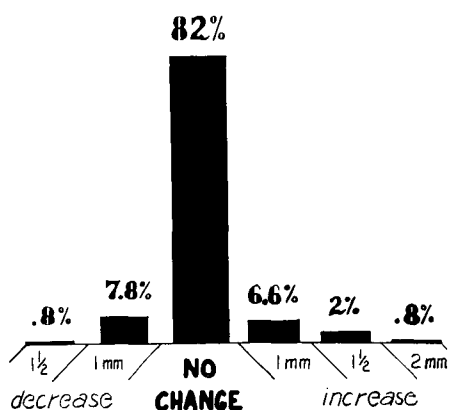


Fig. 2 The change in length of the clinical crown during orthodontic treatment.

Periodontal Index

Prior to treatment, 40% of the patients had a periodontal index of "2", 40% an index of "1", and only 20% had a periodontal index of "0". As treatment progressed, the number of patients who were able to maintain a "0" periodontal index dropped; after eight months of treatment only 10% had a "0" index. The number of patients with periodontal indices of "1" and "2" increased correspondingly. Forty-eight hours after appliance removal, 34% had a periodontal index

of "0", 50% were scored "1", and 16% were scored "2". At the final examination four months later, 54% had a "0" periodontal index, 32% a "1" index, and 14% a "2" index (Fig. 3).

Oral-Debris Index

Before treatment started only 10% of the patients scored 0 to .5, while 74% scored between 1 and 2 and 16% scored 2.5 or 3. As soon as appliances were placed, the percentages of patients with an oral debris index of 0 to .5 increased to 18%, those in the middle group of 1 or 2 increased to 78%, while those with an index of 2.5 to 3 decreased to 4%. These ratios remained fairly constant throughout treatment.

Forty-eight hours after appliance removal, the oral debris index of half of the patients dropped to 0 or .5, and the other half scored 1 to 2. None of the patients scored above 2. Four months later the percentage of patients scoring 0 or .5 dropped to 28%, while those scoring 1 to 2 increased to 68% and those scoring 2.5 to 3 increased to 4% (Fig. 4).

Overall, the patients did a slightly better job of brushing with appliances on than they did prior to

PERIODONTAL INDEX	DURING TREATMENT				AFTER TREATMENT	
	BEFORE	4 mo.	8 mo.	12 mo.	48 hr.	4 mo.
2	40%	32%	46%	41.3%	16%	14%
1	40%	44%	44%	52.2%	50%	32%
0	20%	24%	10%	6.5%	34%	54%

Fig. 3 Distribution of patients by periodontal index (Russell) throughout the course of orthodontic treatment.

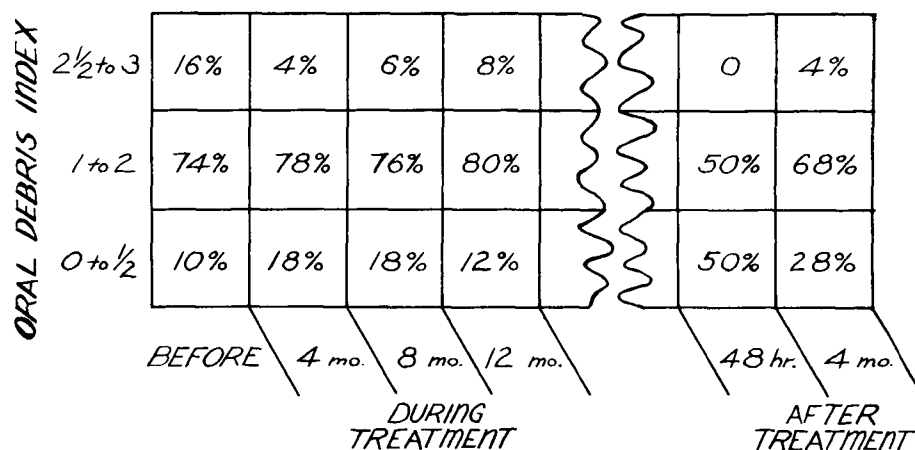


Fig. 4 Distribution of patients by oral debris index (Greene & Vermillion) throughout the course of orthodontic treatment.

treatment. The renewed interest in their teeth was evident immediately following appliance removal with half the patients doing an outstanding job of oral hygiene and the other half doing only fairly well. Another factor influencing the sharp reduction in oral debris index scores forty-eight hours after appliance removal is the fact that only limited plaque accumulation would have taken place in this short time-span following an oral prophylaxis. The general level of home oral hygiene, as indicated by the four-month posttreatment index averages, is better following orthodontic treatment than prior to treatment.

If the oral debris index and the periodontal index are plotted against one another, a straight line relationship results with the periodontal index increasing steadily as the oral debris index increases (Fig. 5). This indicates that the periodontal response of the orthodontic patient is no different than any other dental patient.

DISCUSSION

One of the oft-stated objectives of orthodontic treatment is to promote better dental health and prolong the

life of the dentition. An ideal occlusion should contribute to the health of the dentition first by creating a normal alignment of teeth, thus easing the task of maintaining a high level of oral hygiene. Secondly, by creating a superbly functioning occlusion, the destructive changes in the periodontium caused by abnormal functioning occlusion should be avoided and, lastly, by minimizing destructive periodontal changes by placing the teeth in good position

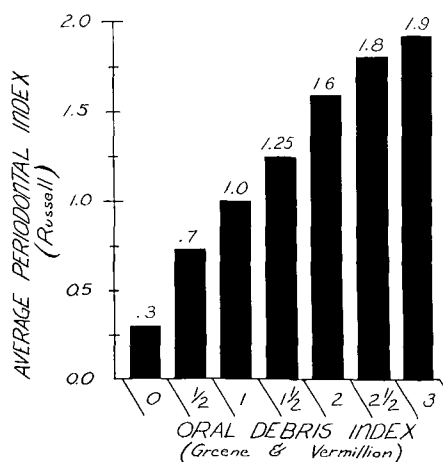


Fig. 5 The comparison of the oral debris index vs. the periodontal index for 330 examinations.

relative to the alveolar bone. If orthodontic treatment or orthodontic appliances cause significant and permanent periodontal pathology, it would be difficult to ever justify orthodontic treatment. Fortunately, no permanent pathologic changes occurred in the periodontium among any of the fifty cases in this study, all of whom were treated with full-banded appliances and the edgewise technique. Since all of the subjects in this study were treated with the same orthodontic technique, it is impossible to predict what changes might occur if other treatment techniques had been employed which would involve extensive tipping of teeth during treatment.

The fact that radiographically detectable periodontal pathology was not evident prior to treatment is not surprising when the ages of the patients are considered. That radiographic evidence of pathology did not occur during treatment is especially encouraging. Despite the favorable age of most orthodontic patients, instances of radiographically detectable pathology would have been observed if the sample had been larger. When this occurs, it will most certainly influence treatment planning.

The greater incidence of gingival hyperplasia around the posterior teeth as compared with the anterior teeth has been reported by others.¹⁰ While there was great variation among individual patients, the fact that the average incidence of gingival hyperplasia was four times greater for the premolar and molar teeth than for the incisors and canines seems significant. The reasons for this distributional difference are 1) mechanical irritation by the orthodontic bands which are more likely to come in contact with the gingiva around the posterior than the anterior teeth; 2) chemical irritation by the exposed cement

at the gingival margin of the band;¹ 3) greater likelihood of food impaction in the posterior areas of the mouth due to proximity of the archwire to the soft tissue; and 4) the tendency for more effective and thorough brushing of the anterior than the posterior teeth.

In considering the distributional pattern of gingival hyperplasia, a four to one ratio exists between gingival hyperplasia occurring interproximally and gingival hyperplasia occurring at the middle of the crown, the greater incidence occurring interproximally. The proximity of the band and hence mechanical irritation of the band and the chemical irritation of the cement is greater at the interproximal areas than at the middle of the crown. The difficulty in brushing the interproximal areas is also an important factor. As long as bands are placed on the teeth, they will result in gingival irritation; however, this can be minimized by proper fitting. Interproximal hygiene can be improved by more thorough tooth brushing. There is evidence to indicate that the use of a water irrigating device is helpful.¹⁵⁻¹⁷

The changes in the length of the clinical crown during orthodontic treatment are not of statistical significance. Most of the teeth measured showed no change in crown length during treatment. The small changes which did occur could be the result of 1) passive eruption,¹⁸ 2) elongation of teeth during treatment, 3) depression of teeth during treatment, and 4) changes in the amount of gingival inflammation.

The high prevalence of gingivitis prior to orthodontic treatment as indicated by Russell's Periodontal Index concurs with the findings of Jamison,¹⁹ Parfitt,²⁰ Ramfjord,²¹ Sheiham²² and others. Russell's index is interpretive as are all methods used for group screening to determine prevalence of

periodontal disease. These findings may vary depending on the person who is doing the examination, but when serial examinations are done by the same person the results can be compared. While orthodontic appliances were in place on the teeth, the percentage of patients who were able to maintain a "0" periodontal index dropped from 20 to 6.5%. This is not surprising since those patients who maintained excellent oral hygiene could not escape the irritation caused by the appliances themselves. Therefore, some gingival inflammation is inevitable when orthodontic appliances are placed on teeth. The dramatic improvement in the gingiva which occurred within forty-eight hours after appliance removal continued during the first four months of retention. At that time, 54% of the sample had no periodontal inflammation present.

There was a significant improvement in home care during treatment as shown by the improvement in the Oral Debris Index scores accounting for the decrease in gingival inflammation following orthodontic treatment. This is due to the great awareness by the patients of the importance of good oral hygiene and also to the important fact that it is easier to maintain a high degree of good oral hygiene when the teeth are in normal alignment.

SUMMARY

The response of the periodontium during and following orthodontic treatment was studied on fifty consecutively-treated orthodontic patients. The edgewise appliance was used for the treatment of all patients. Prior to beginning treatment, at three-month intervals during treatment, and four months after active treatment was completed, each patient was given a periodontal examination consisting of: 1) measurement of the gingival sulcus depth at six locations on each tooth,

2) measurement of the length of the clinical crowns of twelve teeth, 3) determination of the periodontal index as described by Russell, and 4) determination of the oral debris index as described by Greene and Vermillion. Intraoral photographs were taken at each examination and intraoral or panoramic radiographs were taken before and after treatment.

Radiographic evidence of pathology was not detected in any of the patients. Changes in the lengths of the clinical crowns during treatment were not of statistical significance. Gingival hyperplasia in varying amounts occurred in most patients. The incidence of hyperplasia was greater in the posterior areas of the mouth than in the anterior and was greater interproximally than at the center of the crown. The hyperplasia diminished dramatically within forty-eight hours following appliance removal and continued to decrease during the first four months of retention. The effectiveness of the patients' home oral hygiene improved during orthodontic treatment and during the first four months following active treatment.

Inflammatory and hyperplastic changes in the gingiva which occurred during treatment were reversible upon appliance removal and the periodontium was in better health following treatment. Orthodontic treatment did not cause any irreversible periodontal destruction. There was a direct relationship between oral hygiene and periodontal disease.

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BIBLIOGRAPHY

1. Waerhaug, J.: The gingival pocket, *Odont. Tidskrift*. Vol. 60, 1952.
2. Ramfjord, S. P.: Local factors in periodontal disease, *J.A.D.A.* 44:647, 1952.
3. Loe, H.; Theilade, E.; Jansen, S. B.: Experimental gingivitis in man, *J. Periodont.* 36:177, 1965.

4. Theilade, E.; Wright, W. J.; Jensen, S. B.; Loe, H.: Experimental gingivitis in Man. II. A longitudinal clinical and bacteriological investigation. *J. Periodont. Res.* 1:1, 1966.
5. Rosebury, T.: Etiologic factors in periodontal disease, *Oral Surg, Oral Med., Oral Path.*, 5:473, 1952.
6. MacDonald, J. B. and Gibbon, R. J.: The relationship of indigenous bacteria to periodontal disease, *J. D. Res.* 41:320, 1962.
7. Schultz-Handt, S.; Bruce, M. A., and Bibby, B. G.: Bacterial factors in non-specific gingivitis, *J. D. Res.* 33:454, 1954.
8. Ash, M. M.; Gitlin, B. N.; and Smith, W. A.: Correlation between plaque and gingivitis. *J. Periodont.* 35:424, 1964.
9. Pearson, L. E.: Gingival height of lower central incisors, orthodontically treated and untreated. *Angle Orthodont.* 38:337, 1968.
10. Zachrisson, S., and Zachrisson, B. J.: Gingival condition associated with orthodontic treatment. *Angle Orthodont.* 42:26, 1972.
11. Pfeifer, J. S.: Theory behind alveolarplasties. *J. of Wis. Dent. S.* 26:207, 1960.
12. Russell, A. L.: A system of classification and scoring for prevalence surveys of periodontal disease. *J. D. Res.*, 35:350, 1956.
13. Greene, J. C., and Vermillion, J. R.: Oral hygiene index: a method for classifying oral hygiene status. *J.A.D.A.*, 61:172, 1960.
14. Day, C. D. Marshall: Periodontal disease: present status and interpretation of epidemiological research. In Muhler, J. C., and Hine, M. K.: *A Symposium of Preventive Dentistry.* St. Louis, C. V. Mosby Co. p. 174, 1956.
15. Hoover, D. R.; Robinson, H. B. G.; and Billingsby, A.: The comparative effectiveness of the water-pic in a non-instructed population. *J. Periodont.* 39:43, 1968.
16. Lobene, R. R.: The effect of a pulsed water pressure cleaning device on oral health. *J. Periodont.* — *Periodontics*, 40:667, 1969.
17. Toto, P. D.; Evans, C. L.; and Sawinski, V. J.: Effects of water jet rinse and toothbrushing on oral hygiene. *J. Periodont.* — *Periodontics*, 40:296, 1969.
18. Gottlieb, B., and Orban, B.: Active and passive eruption of the teeth, *J. D. Res.* 13:214, 1933.
19. Jamison, H. C.: Prevalence of periodontal disease of the deciduous teeth. *J.A.D.A.*, 66:207, 1963.
20. Parfitt, G. J.: A five year longitudinal study of gingival conditions of a group of children in England. *J. Periodont.*, 28:26, 1957.
21. Ramfjord, S. P.: The periodontal status of boys 11 to 17 years old in Bombay, India. *J. Periodont.*, 32:237, 1961.
22. Sheiham, A.: The prevalence and severity of periodontal disease in survey school children. *D. Practit.*, 19:232, 1969.