Changes in Gingiva and Gingival Flora with Bonding and Banding

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Decalcification, caries, and inflammatory periodontal disease are some of the commonly recognized consequences of the failure to maintain good oral hygiene, especially during orthodontic treatment (BLOOM AND BROWN 1964). The detrimental effects of plaque accumulation around orthodontic brackets and bonds have been well documented, with a chronic, hyperplastic marginal gingivitis being an almost inevitable result of poor plaque control in children (BAER AND COCCARO 1964). If left untreated, this condition may progress in some cases to tissue destruction and highly damaging inflammatory periodontal disease (ZACHRISSON AND ZACHRISSON 1972).

There is now overwhelming evidence to implicate oral microorganisms as the primary etiologic agents of periodontal disease, with different forms of inflammatory periodontal disease being caused by different species of organisms (LÖE ET AL. 1965, LISTGARTEN 1976). A healthy periodontium appears to be associated with scant microbial flora located almost entirely supragingivally (LÖE ET AL. 1965).

Microbial cell accumulations in health are usually 1 to 20 cells thick, and are comprised mainly of gram-positive coccal forms (SOCRANSKY ET AL. 1977). In the healthy gingival crevice, the flora consists mostly of primary gram-positive facultatively anaerobic cocci and rods, in particular various species of *Streptococci* and *Actinomyces* (SLOTS 1977).

These gram-positive organisms still predominate in the microbial flora associated with gingivitis, but there is often an increase in the numbers of gram-

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negative anaerobic rods of the *Fusobacterium* and *Bacteroides* types (SLOTS ET AL. 1978). Progress to destructive periodontitis in adults frequently coincides with the dominance of the gram-negative facultative anaerobes and the presence of increasing numbers of motile organisms such as spirochetes (PAGE AND SCHROEDER 1976). These species show a high pathogenic potential to periodontal tissues, since they elaborate various cytotoxic products that include an array of enzymes capable of hydrolyzing gingival tissues (MACDONALD ET AL. 1963, NISENGARD AND GENCO 1977).

Clinical and experimental studies have demonstrated that the most important etiologic factor in inflammatory periodontal disease is the presence of bacterial plaque at or below the gingival margin. The introduction of fixed orthodontic appliances into the mouth increases the number of areas for potential plaque retention, and thus the possibility of progressing from a gingivitis to a periodontitis (ZACHRISSON AND ALNAES 1973). Fortunately, the gingivitis seen so frequently in children seems to rarely progress to destructive periodontitis (BAER AND COCCARO 1964).

Pathologic changes in the gingiva have nevertheless been noted in children, but little information is available on the extent, frequency, or severity of these changes (SPENCE 1955). The interproximal areas have been consistently shown to be affected more, particularly around posterior teeth. ZACHRISSON AND ZACHRISSON (1972) found that removal of the orthodontic appliances produced significant improvements in gingival health within one month of debanding. However, no attempts have been made to correlate these changes with the number and type of microbial flora present in the gingival crevice (LÖE ET AL. 1965).

Several researchers have attempted to quantify the distribution of organisms present in the plaque of orthodontic patients, but technical problems have confined these evaluations to supragingival plaque (BLOOM AND BROWN 1964, BALENSEIFEN AND MADONIA 1970, KEY 1981, HARDIE AND BOWDEN 1976, AND SOCRANSKY ET AL. 1963).

With the recent development of techniques for the collection, isolation and cultivation of anaerobic flora, it has now become possible to determine the nature and type of microorganisms that might reside in the gingival crevice adjacent to orthodontic appliances (SYED AND LOESCHE 1972, LOESCHE AND SYED 1973, AND SLOTS 1975).

The purpose of this study is to evaluate the changes in gingival health and in subgingival microbial flora associated with fixed orthodontic appliances.

— Materials and Methods —

The study sample is comprised of 13 orthodontic patients (5 male and 8 female), all Caucasian, ranging in age from 12 to 16 years (mean 14yrs 1mo) at the start of orthodontic treatment. The subjects were randomly selected without regard for type of malocclusion, had no mouth breathing, tongue or digit habits, and showed no abnormal hard or soft tissue morphology. All were screened to ensure that there was no history of recent orthodontic treatment, systemic disease, or a course of antibiotic therapy within the preceding six months.

All subjects completed an oral hygiene program consisting of three instructional visits covering the "modified Bass" toothbrushing technique and the use of dental floss. Plaque and gingival indices were recorded according to LÖE (1967). The importance of oral hygiene was stressed and evaluated throughout the study. No fluoride rinses or gels were used either before or during the study, to

exclude their influence on the microbial flora in the gingival crevice.

Baseline clinical and bacteriological data were recorded for the maxillary and mandibular central incisors and the maxillary and mandibular right first permanent molars prior to the placement of orthodontic appliances. Dry field sampling was accomplished through the use of cheek retractors, cotton rolls and high-volume aspiration.

The parameters evaluated on each of the four teeth were:

Gingival Index

The gingival index was calculated at six sites (3 buccal and 3 lingual) on each on the four teeth evaluated (LÖE 1967).

Plaque Index

The plaque index was measured at 6 sites (3 buccal, 3 lingual) on each of the four teeth (SCHEIE ET AL. 1984). Any remaining supragingival plaque was then removed with a scaler and the teeth carefully washed and dried prior to subgingival plaque collection.

Subgingival Plaque Collection

Subgingival plaque samples were taken from four sites in each patient — the distobuccal gingival crevice of the upper and lower central incisors, as close as possible to the contact point, and the mesiobuccal gingival crevices of the upper and lower right first molars adjacent to the contact point.

The subgingival plaque samples were collected using 20mm lengths of .016″ stainless steel orthodontic wire. The tip was smoothed, and a 45° bend placed 5mm from the tip to facilitate insertion in the crevice. This tip was gently passed through the gingival crevice of one of the four sampling sites as a stream of nitrogen gas was directed onto the sampling area to minimize oxygen exposure of any anaerobic flora.

The wire with the collected subgingival plaque sample on its tip was then transferred in a flow of nitrogen gas to a plastic transport tube containing 1.0ml of reduced transport fluid suitable for maintaining the collected organisms. This procedure was repeated for each sampling site.

Each transport tube was flushed with nitrogen gas and sealed to maintain an essentially anaerobic environment. The transport tubes were placed in an anaerobic culture chamber with an atmosphere of 5% carbon dioxide, 10% hydrogen, and 85% nitrogen, with an average oxygen concentration of 20 parts per million. The samples were vortexed for 30 seconds and diluted with 4.0ml of reduced transport fluid.

Next, 0.1ml was removed from each tube to be plated onto each of five selective media — Bacitracin agar, CNAC-20 agar, Trypticase Peptone blood agar, Kanamycin-Vancomycin laked blood agar, and Brucella agar for spirochetes. Each medium was suitable to support growth of one of the five major groups of bacteria commonly found in subgingival plaque samples.

Each plaque sample was inoculated in triplicate sets of plates and cultured for four days in an anaerobic chamber equilibrated to 37°C. A count of the total viable organisms present on each culture plate was determined using a Quebec colony counter. The relative proportions of the different types of organisms were determined for each sample site by calculating the mean counts for the triplicate plates of the five types of medium used for each of the four teeth evaluated.

Pocket Depths

Pocket depths were assessed using a Marquis probe at 6 sites (3 buccal and 3

lingual) on each of the four teeth evaluated.

Orthodontic appliances were fitted after collection of this baseline data. Direct bonded brackets were placed on the incisors, and bands cemented on the molars.

After one year of orthodontic treatment, a second complete set of data was collected on each patient for comparison with the pretreatment values. The data generated from the two sampling periods were statistically analyzed using a two-way analysis of variance and Student's T-test for unmatched data. A level of significance of $p \leq 0.05$ was selected, and correlations were evaluated using the Pearson product-moment correlation coefficient.

— Results —

Few major changes in oral health were noted over the year in orthodontic appliances. The pretreatment (T^1) and one-year (T^2) supragingival plaque indices were very similar, with no significant changes noted on any of the four teeth evaluated. Plaque levels were similar for the bonded and the banded teeth, and evaluation of the segregated plaque scores for the labial surfaces also failed to reveal any significant differences in plaque accumulation (Table 1).

The gingival index, however, did show a significant ($p < 0.05$) increase from T^1 to T^2 for each of the two bonded incisors, but not for the two banded molars. The mean increase of 0.55 ($p < 0.05$) for the two bonded incisors was significantly greater ($p < 0.05$) than the 0.32 (p=NS) increase seen for the two banded molars.

Comparison of the changes on the labial and lingual surfaces showed that almost the entire increase in the gingival index could be attributed to changes on the labial surfaces of the two bonded incisors (+0.58, $p < 0.05$) and the banded molars (+0.44, $p < 0.05$) (Table 2).

Pocket depth increases were small, with p values reaching the .05 level of significance only when the sample size was increased by pooling different teeth (Table 3).

On the other hand, the microbiologic data did show significant change during the period with orthodontic attachments. The percentage of each of the five types of organisms in the microbial flora was altered, with the most noticeable change in the streptococci, which constituted 17.5% more of the flora at T^2 ($p < 0.01$).

Conversely, the actinomyces-like organisms constituted 13.3% less of the overall flora ($p < 0.05$). Minor reductions were also seen in *Fusobacterium* and *Bacteroides* species. Only a small, statistically insignificant increase was noted for the potentially pathogenic spirochetes which tend to become more plentiful in deep anaerobic pockets (Table 4) (Fig. 1).

Table 1

Plaque Index Scores

	Time 1 mean±SD	Time 2 mean±SD	Change T_2-T_1	p
UI	0.77±0.53	0.85±0.59	+0.08	NS
LI	0.88±0.46	0.93±0.68	+0.05	NS
U6	0.86±0.35	0.72±0.49	−0.14	NS
L6	0.98±0.36	0.75±0.55	−0.24	NS
Mean	0.87±0.43	0.81±0.56	−0.06	NS

Evaluation of the interactions between the various parameters examined revealed few significant relationships.

A correlation was noted between the pretreatment plaque and gingival indices ($r=0.84$). This relationship was present at T^2 ($r=0.78$) for all four teeth examined. No significant correlations could be found between the gingival index and the depth of the patient's pockets, or between plaque levels and pocket depths over the one-year treatment period.

Nor could a correlation be found between either of the two significant changes seen in the microbial flora spectrum and any of the changes in gingival index.

— Discussion —

Little deterioration in oral hygiene status was found after one year in fixed orthodontic appliances. Supragingival plaque levels did not rise significantly, and even in the presence of gingivitis there were only small increases in pocket depth. Gingivitis was seen primarily on the bonded incisors, rather than on the banded molars, and it was particularly marked on the labial surfaces.

It may be that the presence of the orthodontic attachments on the labial surfaces of these teeth might be responsible for the changes observed, perhaps due to their interference with thorough brushing of the gingival area (GWINETT AND CEEN 1979).

The gingival changes could also be attributed to the presence of rough-surfaced plastic bonding material acting as a plaque-trap and gingival irritant (SAKAMAKI AND BAHN 1968, SCHEIE ET AL. 1984, MATTINGLY ET AL. 1983). Thorough removal of excess bonding material adjacent to the gingiva could be vital if this assumption is proven correct.

Table 2

Gingival Index Scores

	Time 1 mean±SD	Time 2 mean±SD	Change T_2-T_1	p
U1	0.91±0.49	1.43±0.38	+0.52	<0.05
L1	0.86±0.53	1.53±0.51	+0.67	<0.05
U6	1.00±0.38	1.42±0.43	+0.42	NS
L6	0.99±0.35	1.20±0.43	+0.21	NS
Mean	0.93±0.38	1.36±0.32	+0.43	<0.05

Table 3

Pocket Depth Measurements (mm)

	Time 1 mean±SD	Time 2 mean±SD	Change T_2-T_1	p
U1	2.29±0.45	2.62±0.55	+0.33	NS
L1	2.13±0.35	2.34±0.22	+0.19	NS
U6	2.39±0.43	2.48±0.28	+0.09	NS
L6	2.55±0.36	2.70±0.31	+0.15	NS
Mean	2.34±0.35	2.53±0.34	+0.19	<0.01

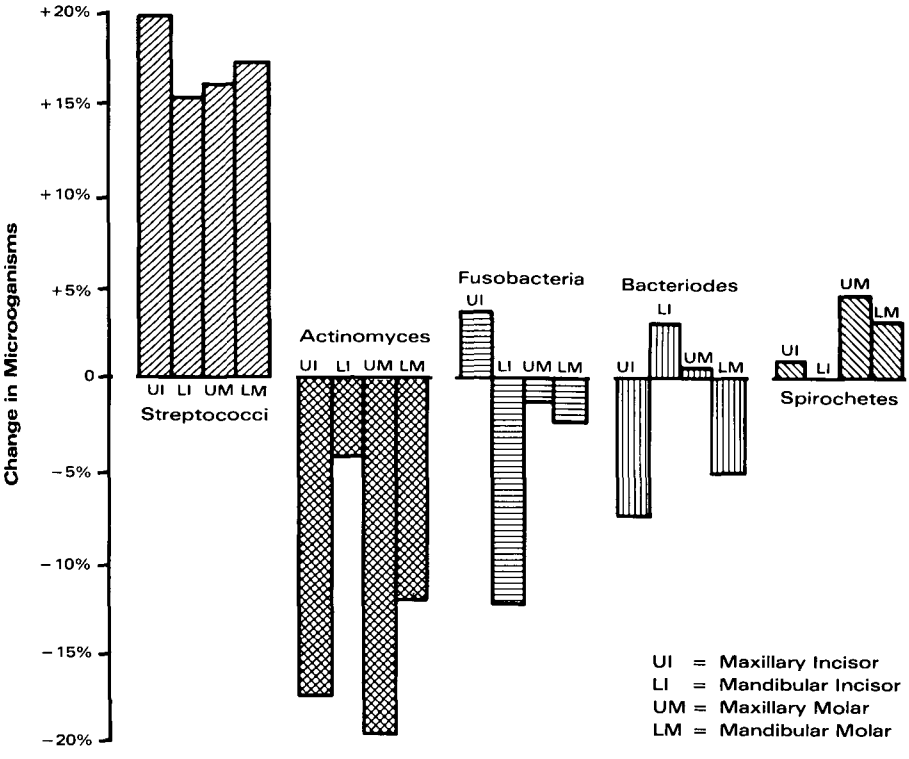

Fig. 1 Percentage change in microbial types comprising subgingival plaque flora from T_1 to T_2.

Table 4

Changes in Microbial Flora Spectrum

	UI	LI	U6	L6	Mean
Streptococci	+20.9%**	+15.2%**	+16.6%**	+17.2%***	+17.5%**
Actinomyces	−17.2%*	−4.6%	−19.5%	−11.9%	−13.3%*
Fusobacteria	+3.1%	−13.6%	−1.4%	−2.8%	−3.7%
Bacteroides	−7.6%**	+3.0%	+0.1%	−5.9%*	−2.7%
Spirochetes	+0.9%	0.0%	+4.6%	+3.4%	+2.2%

* $p<0.05$ ** $p<0.01$ *** $p<0.001$

This hypothesis is supported by the data showing the only significant increase in pocket depths occurring adjacent to the bonded brackets. While demonstrating a correlation between orthodontic appliances and plaque level at both T^1 and T^2, no relationship could be found between gingivitis and pocket depth (ZACRISSON AND ZACRISSON 1972, MACKLER AND CRAWFORD 1973, AND MATSSON 1978).

Other authors have shown an increase in the number of streptococci in supragingival plaque, similar to that found in the subgingival plaque sampled in this study, and they have suggested that an increase in streptococcal flora can lead to a higher incidence of caries (ARNEBERG ET AL. 1984, CORBETT ET AL. 1981).

The lack of correlation between changes in subgingival microbial flora and gingival changes might suggest that the subgingival organisms alone were not directly responsible for the gingivitis. The supragingival plaque, which was not sampled in this study, has been shown to hold increased streptococcal populations after the placement of orthodontic appliances, and this might have contributed to the changes in gingival health (SCHEIE ET AL. 1984, MATTINGLY ET AL. 1983).

This study found no significant increase in the number of highly pathogenic Gram-negative anaerobic organisms which have been strongly implicated in gingivitis and periodontitis in adults (PAGE AND SCHROEDER 1976, MACDONALD ET AL. 1963, AND NISENGARD AND GENCO 1977). This may be due to the relatively good oral hygiene, with little increase in plaque accumulation, preventing the formation of any significant pockets.

It should also be noted that the incidence of destructive inflammatory periodontal disease is lower in children, where gingivitis appears to be characterized by a rather heterogeneous group of organisms including *Bacteroides* and *Clostridium* species rather than the Gram-negative organisms seen in adult periodontitis (SASAKI ET AL. 1977).

More definitive information on the effects of orthodontic appliances on periodontal health could be derived from similar studies conducted over longer periods, evaluating the recovery of the tissues and subgingival microbial flora after the removal of orthodontic appliances. Changes in populations with poor oral hygiene and in adults should alsp be evaluated.

— Conclusions —

This study finds the following conditions after one year in fixed orthodontic appliances, with a relatively good standard of oral hygiene —

- no significant increase in plaque levels around the appliances
- mild gingivitis, particularly on the labial surfaces of bonded incisors adjacent to the orthodontic attachments
- a small but significant increase in pocket depths adjacent to brackets on incisors
- an increase in the percentage of *Streptococci* and a decrease in the percentage of *Actinomyces* in the subgingival plaque
- no increase in the percentage of potentially pathogenic Gram-negative organisms frequently associated with inflammatory periodontal disease.
- no correlation between changes in the subgingival microbial flora and gingival condition.

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