GINGIVITIS

AND

LOCAL FACTORS

A Thesis

Presented in Partial Fulfillment of the Requirements for the Degree Master of Science

by

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INTRODUCTION

The near-universality of periodontal disease is beyond question.\textsuperscript{1-5} Nor is the affliction limited to the middle-aged and older for it is found in the young\textsuperscript{6} and in the very young.\textsuperscript{7} Its treatment and especially its prevention, therefore, is of great concern to the dental profession.

Although many causes of periodontitis have been suggested\textsuperscript{8,9,10} successful treatment of the disease is based primarily on the control or elimination of local factors such as oral micro-organisms, calculus, overextended margins of restorations, irritating prostheses, oral debris, food impaction and retention, traumatogenic occlusion, mouthbreathing, oral habits and destructive use of toothpicks, floss and toothbrush.

Purpose of the Present Study

The purpose of this study was to determine the distribution patterns of and the relationship between clinically evident gingivitis and local factors.
REVIEW OF THE LITERATURE

Although many investigators have reported epidemiological studies of gingivitis,11-15 little has been reported concerning gingivitis and local factors on a tooth-surface vs. adjacent-gingiva basis.

Lovdal and others16 studied the distribution and incidence of subgingival calculus and gingivitis on the buccal, lingual, mesial and distal surfaces of twelve hundred men. They found gingivitis and subgingival calculus least often buccally and most often interproximally. They also found that inflammation was more common than subgingival calculus. They did not study "uncalcified bacterial deposits" but suggested that these deposits might be responsible for the difference. They also suggested that a causative factor for gingivitis might be faulty restorations.

The same investigators(16) and Shei17 found that gingivitis decreased as the efficiency of toothbrushing increased and concluded that "the importance of removing bacterial plaque in contact with the gingiva is clearly demonstrated." It is not clear, though, whether they did or did not record plaque as being in contact with the gingiva.
In a study on the effect of automatic and hand toothbrushing on gingivitis, Hoover and Robinson\textsuperscript{18} found that, in a pretest evaluation of their subjects, both the normal group and the gingivitis group had the same amount of plaque. They concluded that for their subjects "plaque per se could not be considered an etiologic agent for gingivitis."

In a study of local factors and periodontal disease, Wright\textsuperscript{19} examined three hundred and twenty males. He used the periodontal index of Russell and a modification of the Greene and Vermillion Oral Hygiene Index in addition to his own indices for caries and overhangs. It appeared that calculus was associated with more severe periodontal destruction than were the other recorded factors. Calculus was found in 95 per cent of the subjects examined, overhanging margins of restorations in 57 per cent, and carious lesions involving the marginal gingiva in 43 per cent of the sample. Oral debris was reported as the most prevalent local factor recorded, although it was least frequently associated with gingival inflammation.
MATERIALS AND METHODS

Subjects for Examination

Forty-three subjects, from 15 to 59 years of age, were selected from patients undergoing examination in the Oral Diagnosis Department, College of Dentistry, The Ohio State University. Subjects were included in the study only if they had more than twenty permanent teeth and no partially erupted teeth other than third molars. Not included were persons who wore removable partial prostheses or who evidenced alveolar bone loss roentgenographically or had gingival crevices deeper than five millimeters.

Criteria for Grading

The facial and interproximal portions of all teeth and gingivae of all subjects were evaluated with respect to the presence of local factors and inflammation.

The local factors considered were:

1. Fuchsin-stainable deposits, hard or soft, located on the tooth and adjacent to the gingiva. Two grades of deposits were recorded:
   DI - a sliverlike stain less than 0.5 mm wide.
   DII - stained deposit more than 0.5 mm wide.
(No estimation of volumetric quantity was attempted.)
2. Gross irregularities of the contour of the tooth surface in contact with adjacent gingiva. Such local factors would include overhanging or underfilled margins of restorations, chipped enamel surfaces, or carious surfaces. These factors were recorded with the letter "O" ("overhangs").

3. Calculus. Calculus was recorded as being present on a tooth surface if it was distinguishable from overhangs, chipped or carious enamel, or the cemento-enamel junction. In case of uncertainty, calculus was recorded as being absent.

The gingivae were examined for severity of inflammation using the following criteria:

Grade 0 - no clinical evidence of inflammation.
Grade 1 - any visible change in the color, tone or contour of the gingiva such as redness or swelling of the gingiva or a smooth rounding of the margin of the gingiva.
Grade 2 - bleeding from the gingival sulcus elicited by gentle exploration with the rounded tip of a dental probe.
Grade 3 - a combination of grades 1 and 2.
Surfaces Graded (Fig. 1)

In this study the facial gingiva of a tooth was considered as two gingival units, marginal and papillary. The gingival papilla distal to a tooth was its papillary unit. The papillae between the maxillary and mandibular central incisors were recorded as frenular papillae.

The facial and interproximal surfaces of a tooth were considered as three surfaces: mesial, facial and distal.

A full complement of teeth consisted of sixty-six gingival units and ninety-six tooth surfaces. Each papillary unit had adjacent to it two tooth surfaces while each marginal unit had one.

Examination of Subjects

The subjects were aware that they were cooperating in a "survey of oral and dental health." They had been given no instructions other than when and where to report for examination.

Each subject was examined in a dental chair with adequate light.

After the subject had rinsed his mouth with four ounces of water for ten seconds, his gingivae were evaluated for grades 0 and 1 inflammation. The gingival units were dried with air and examined with direct vision where possible and by means of a mouth mirror where necessary.
DIAGRAM ILLUSTRATING GINGIVAL UNITS AND TOOTH SURFACES EXAMINED IN THIS STUDY

Gingival units:  
- P = papillary unit
- M' = marginal unit

Tooth surfaces:  
- M = mesial surface
- F = facial (labial or buccal) surface
- D = distal surface

Figure 1
After the examination for grade 1 gingivitis was completed, stainable deposits were scored. The subject rinsed for five seconds with basic fuchsin* and then for three seconds with water. The tooth surfaces were air-dried and scored for stained deposits.

Subsequent examinations were made for grade 2 gingivitis, for calculus, and for "overhangs."

After all examinations the patient was given a questionnaire concerning his oral health practices. (Fig. 2)

Compilation and Analysis of Data

All data recorded on score sheets (Fig. 3) were subsequently transferred to a master score sheet from which patterns of distribution of calculus, deposits and inflammation could be determined and graphed. (Fig. 4)

The evaluation was complicated by the existence of twelve possibilities for occurrence of local factors. The tooth surface adjacent to a given gingival unit of grade 0, 1, 2, or 3 inflammation was susceptible to these twelve possibilities:

1. Ø = no recorded local factors
2. DI = stained deposit less than 0.5 mm wide.
3. DII = stained deposit more than 0.5 mm wide.

*3 drops of a 6% tincture of basic fuchsin in 5 cc. of water.
Last name, First name, Initial  Age

How long has it been since you ate anything?
How long has it been since you brushed your teeth?
Do you hold your toothbrush in your right or left hand?
Did a dentist or dental hygienist ever show you a method of brushing?
If "Yes":
  How long ago?
  Did you ever use that method?
  Do you use that method now?
Do you feel that you brush your teeth well?
Do you feel that you brush often enough? (This does not necessarily mean "after every meal.")
Normally, how often do you brush?

Figure 2. ORAL HEALTH QUESTIONNAIRE
**I** - Row in which grade 1 inflammation was recorded

**II** - Row in which grade 2 inflammation was recorded

**D** - Row in which stained deposits were recorded

**O** - Row in which overhangs were recorded

**C** - Row in which calculus was recorded

---

**Figure 3. SAMPLE SCORE SHEET**
Figure 4
4. O = overhangs, etc.
5. C = calculus
6. O+C
7. DI+O
8. DI+C
9. DI+O+C
10. DII+O
11. DII+C
12. DII+O+C

The frequency of occurrence of these combinations of local factors with the different grades of inflammation were tabulated (Fig. 5). These data permitted analysis of the correlation of recorded local factors with gingivitis on a gingival unit — tooth surface basis.

Indices for inflammation, for calculus, and for stained deposits were calculated for each patient.

The Inflammation Index was based on the number of gingival units of grades 1, 2 and 3 inflammation and on the total number of gingival units examined in the subject's mouth. The index is represented by the formula

\[
\text{Index} = \frac{(U_1 x 1) + (U_2 x 2) + (U_3 x 3)}{\text{GUE}}
\]

where:

\[U_1 = \text{number of gingival units of grade 1 inflammation}\]
\( U_2 = \) number of gingival units of grade 2 inflammation

\( U_3 = \) number of gingival units of grade 3 inflammation

GUE = number of gingival units examined in the subject

It can be seen that the range is 0.00 (no units inflamed) to 3.00 (all units grade 3).

The Stained Deposits Index was based on two grades (DI and DII) and the number of tooth surfaces examined. Its range is from 0.00 to 2.00.

Calculus having been recorded as present on or absent from a given tooth surface, the Calculus Index has a range of 0.00 to 1.00.

All data were submitted for analysis to the Statistics Laboratory, Department of Mathematics, The Ohio State University.
<table>
<thead>
<tr>
<th>Local Factors</th>
<th>Number of Gingival Units of Indicated Grades of Inflammation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Ø</td>
<td>454</td>
</tr>
<tr>
<td>DI</td>
<td>98</td>
</tr>
<tr>
<td>DII</td>
<td>539</td>
</tr>
<tr>
<td>O</td>
<td>7</td>
</tr>
<tr>
<td>C</td>
<td>21</td>
</tr>
<tr>
<td>O+C</td>
<td>1</td>
</tr>
<tr>
<td>DI+O</td>
<td>2</td>
</tr>
<tr>
<td>DI+C</td>
<td>18</td>
</tr>
<tr>
<td>DI+O+C</td>
<td>0</td>
</tr>
<tr>
<td>DII+O</td>
<td>24</td>
</tr>
<tr>
<td>DII+C</td>
<td>185</td>
</tr>
<tr>
<td>DII+O+C</td>
<td>14</td>
</tr>
</tbody>
</table>

Figure 5. TABLE OF FREQUENCY OF OCCURRENCE OF VARIOUS LOCAL FACTORS AND GRADES OF INFLAMMATION (2503 gingival units in 43 subjects)
RESULTS

General

Inflammation was observed in 45.6 per cent of the gingival units examined (Fig. 6). Calculus, stained deposits and overhangs were found on tooth surfaces adjacent to 94.5 per cent of the inflamed gingival units. There were 75 inflamed gingival units for which no local factors were recorded; of these, 44 were marginal units whose adjacent papillae were inflamed. Even if contiguous inflammation is considered a local factor there remained 31 inflamed gingival units for which inflammation could not be explained by the presence of local factors recorded in this study.

Patterns of Distribution

From the graph (Fig. 4) it can be seen that the segments of the maxillary and mandibular arches most frequently associated with inflammation were, in descending order:

- Maxillary left posterior - avg. 56.2%
- Mandibular anterior - avg. 47.8%
- Maxillary right posterior - avg. 37.9%
- Mandibular right posterior - avg. 36.3%
- Maxillary anterior - avg. 34.6%
- Mandibular left posterior - avg. 33.2%
<table>
<thead>
<tr>
<th></th>
<th>NUMBER</th>
<th>% OF TOTAL</th>
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</thead>
<tbody>
<tr>
<td>Total Examined</td>
<td>2503</td>
<td>100.0</td>
</tr>
<tr>
<td>Not inflamed</td>
<td>1363</td>
<td>54.4</td>
</tr>
<tr>
<td>Inflamed</td>
<td>1140</td>
<td>45.6</td>
</tr>
<tr>
<td>Grade 1</td>
<td>619</td>
<td>24.8</td>
</tr>
<tr>
<td>Grade 2</td>
<td>103</td>
<td>4.1</td>
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<tr>
<td>Grade 3</td>
<td>418</td>
<td>16.7</td>
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</table>

Figure 6. GINGIVAL UNITS AND INFLAMMATION IN 43 SUBJECTS.
In these segments, the gingival units most frequently inflamed were the papillae distal to the

Maxillary left first molar 87.8%
Maxillary right lateral incisor 66.6%
Mandibular right second molar 63.4%
Mandibular left second premolar 53.7%
Mandibular right first molar 52.6%
Maxillary left central incisor and canine 48.8%

Least frequently affected in the segments were the marginal gingivae of the

Maxillary right first premolar 9.3%
Mandibular left first premolar 13.9%
Maxillary left first premolar 17.5%
Maxillary left lateral incisor and canine 20.9%
Mandibular right first premolar 21.4%
Mandibular right canine 27.9%

There is a noticeable difference between the maxillary and mandibular arches in the relationship of calculus and inflammation. In the maxilla, inflammation was found in the absence of calculus, both interproximally and facially. In the mandible, however, this relationship was found only facially. Interproximally, calculus was found in the absence of inflammation.
Relationships between Local Factors and Gingivitis

All subjects had gingival inflammation ranging from three gingival units of grade 1 inflammation (Inflammation Index = 0.05) to sixteen grade 1 units and thirty-five grade 3 units (I.I. = 2.24). The mean Inflammation Index for the group was 0.85.

Only one subject was free of calculus on the tooth surfaces examined. The Calculus Indices ranged from 0.00 to 0.77 with a mean of 0.33.

All subjects had stainable deposits on their teeth. The Deposits Indices ranged from 0.48 to 2.00 with a mean of 1.45.

Analysis of the data on a total-mouth basis indicates a high degree of correlation (T value less than 0.01) between the amounts of calculus and of inflammation and between the amounts of stainable deposit and of inflammation (T value less than 0.05).

When calculus and stainable deposits are considered on a tooth-surface vs. gingival-unit basis, however, their importance as etiologic factors appears in a different light.

Figure 7 is a table of predictability based on analysis of the data provided in the table in Figure 5. It indicates the average degree of gingival inflammation that can be expected adjacent to tooth surfaces bearing a given
<table>
<thead>
<tr>
<th>Predicted Average</th>
<th>Inflammation Per Gingival Unit</th>
<th>Local Factors</th>
<th>Number of Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.00</td>
<td>DI+O+C</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2.24</td>
<td>DII+O+C</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>1.75</td>
<td>O+C</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1.73</td>
<td>O</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>1.49</td>
<td>DII+C</td>
<td>646</td>
</tr>
<tr>
<td></td>
<td>1.29</td>
<td>DII+O</td>
<td>69</td>
</tr>
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<td></td>
<td>1.20</td>
<td>DI+O</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>0.66</td>
<td>DI+C **</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>0.66</td>
<td>C *</td>
<td>35</td>
</tr>
<tr>
<td></td>
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<td>DII *</td>
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<td></td>
<td>0.39</td>
<td>DI **</td>
<td>139</td>
</tr>
<tr>
<td></td>
<td>0.18</td>
<td>Ø **</td>
<td>529</td>
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</tbody>
</table>

*T value less than 0.05

**T value less than 0.01

Figure 7. TABLE OF PREDICTABILITY
local factor or combination of local factors when the subject examined meets the requirements for this study.

It is important to consider what the table does not indicate. For example, the conclusion cannot be drawn that if calculus is found alone on a given tooth surface the adjacent gingival inflammation will not be greater than grade 1. The likelihood that the preceding conclusion would be true is greater (T value less than 0.05) than the assumption that gingival inflammation will not exceed grade 2 when an overhang is present alone. (T value greater than 0.05.)

Calculus or stainable deposits alone seem to play a less important role in the degree of inflammation than do overhangs.
DISCUSSION

The finding that 31 gingival units were inflamed without the presence of recorded adjacent local factors was probably due to the occurrence of etiologic agents other than those recorded in this study. It may be concluded that overhangs, calculus, and deposits should not be considered totally responsible for the inflammation, although they were frequently found associated with gingivitis.

Lovdal and others\textsuperscript{16} found that gingivitis and calculus occurred most frequently interproximally. These observations were confirmed in this study. Stained deposits on the teeth also were found to follow that same pattern.

The greater association of calculus with inflammation than of stained deposits on a total mouth basis, agrees with the findings of Wright.\textsuperscript{19} It should be emphasized that the importance of these relationships may be more apparent than real since they are based on the total amounts of calculus and deposits present. On a tooth-surface vs. gingival-unit basis there is only a slight difference between the amount of inflammation associated with calculus and that associated with deposits (Fig. 7). On a total-mouth basis the difference may be cumulative, indicating more importance for calculus than for deposits.
When considering local factors on a given tooth surface and inflammation of the adjacent gingiva, it is more meaningful to consider all combinations of local factors rather than only the individual local factors. This concept helps to explain the finding that overhangs apparently play a more important role in the degree of inflammation than do calculus or deposits alone. By their very nature, calculus and deposits consist, in great part, of microorganisms but were considered as separate, single local factors. Perhaps the recording of an overhang in this study was in reality a recording of two local factors: an overhang and microorganisms.

Waerhaug explained the inflammation found around some artificial crowns as being the result, not of the restorative material itself, rather of the accumulation of bacterial plaque at inexactlly fitted margins of the crowns.

It seems evident that the role of local factors is a complex one. The results of the present study indicated that the degree of inflammation increased as the number of local factors increased. It is reasonable to assume that there may be a potentiating effect when a ready supply of microorganisms (deposit) is available to a fixed site of action (calculus or overhangs).
CONCLUSIONS

1. Calculus, stainable deposits and inflammation were found more frequently interproximally than facially.

2. On a total-mouth basis, there was greater correlation between calculus and gingivitis than between stainable deposits and gingivitis.

3. On a tooth-surface vs. gingival-unit basis, calculus was, to a small degree, associated with more inflammation than were deposits.

4. In a subject meeting the requirements for inclusion in this study, if calculus or deposits should be found alone on a given tooth surface, it would be unlikely that the adjacent gingiva would be so inflamed as to result in bleeding from gentle instrumentation of the gingival crevice.

5. Inflammation of a gingival unit increased with an increase in the number of local factors found on the adjacent tooth surface.
REFERENCES


