Scaling and root planing with and without periodontal flap surgery


Abstract. Complete removal of calculus is a primary part of achieving a "biologically acceptable" tooth surface in the treatment of periodontitis. Rabbani et al. reported that a single episode of scaling did not completely remove subgingival calculus and that the deeper the periodontal pocket, the less complete the calculus removal. The purpose of the present study was to evaluate the effectiveness of scaling relative to calculus removal following reflection of a periodontal flap. Each of 21 patients who required multiple extractions had 2 teeth scaled, 2 teeth scaled following the reflection of a periodontal flap, and 2 teeth served as controls. Local anesthesia was used. Following extraction, the % of subgingival tooth surfaces free of calculus was determined using the method described by Rabbani with a stereomicroscope. Results showed that while scaling only (SO) and scaling with a flap (SF) increased the % of root surface without calculus, scaling following the reflection of a flap aided calculus removal in pockets 4 mm and deeper. Comparison of SO versus SF at various pocket depths for % of tooth surfaces completely free of calculus showed 1 to 3 mm pockets to be 86% versus 86%, 4 to 6 mm pockets to be 43% versus 76% and >6 mm pockets to be 32% versus 50%. The extent of residual calculus was directly related to pocket depth, was greater following scaling only, and was greatest at the CEJ or in association with grooves, fossae or furcations. No differences were noted between anterior and posterior teeth or between different tooth surfaces.

The primary etiologic agents in periodontitis are bacterial plaque and calculus. Correlation of supragingival plaque and calculus with gingivitis and periodontitis has been demonstrated in several studies (Lindhe et al. 1973, 1975, Loe et al. 1965, Theilade et al. 1966). Scaling and root planing are widely used techniques in periodontal therapy to remove irritants from the surfaces of the teeth and also to reduce tooth surface roughness which may facilitate the accumulation of irritants (Waerhaug 1956).


A great number of studies (Frumker & Gardner 1956, Jones et al. 1972, Jones & O'Leary 1978, Schaffer 1956, Walker & Ash 1976) have shown that despite the best efforts of different clinicians to thoroughly root plane teeth, considerable amounts of calculus remained, although the surface was clinically smooth (Waerhaug 1978b). Investigations have shown that incomplete calculus removal may be discovered after periodontal flap procedures (Waerhaug 1975, Waerhaug 1978a, b). It has been observed that complete removal of plaque and calculus was more difficult in deep pockets than in shallow pockets (Lovdal et al. 1961, Rabbani et al. 1981, Waerhaug 1978b). Tooth type did not influence the results obtained (Rabbani et al. 1981). Areas of calculus retention such as resorption bays, interradicular areas, the cemento-enamel junction, and carious defects (Jones et al. 1972) have been described. The use of explorer tips failed to differentiate between burnished calculus and cementum and appeared not to be an accurate means of assessing calculus removal (Jones & O'Leary 1978, Rabbani et al. 1981).

The purpose of the present study was to evaluate the effectiveness of scaling and root planing on calculus removal, both with and without the use of a periodontal flap for access.

Material and Methods
The subjects were selected from patients scheduled for treatment at The University of Michigan School of Dentistry or the Veterans Administration Medical Center Dental Service in Ann Arbor, Michigan. All patients had been scheduled for immediate complete denture treatment. Extractions were deemed necessary due to periodontal disease. In order to participate in the study, the patients had to have at least 6 teeth.
of any type scheduled for extraction. A total of 21 patients (15 male, 6 female) ranging in age from 29 to 88 years (mean 52.7 years) participated in the study. None of the patients had previously received any periodontal treatment other than routine prophylaxis at a dentist's office.

After a thorough explanation of the purpose of the study, each patient was asked to sign a consent form. An assessment of the periodontal status was made for each patient by measuring pocket depth and the amount of calculus present. Prior to extraction, 2 of the 6 teeth were anesthetized, scaled and root planed. An inverted cone bur was used to mark the levels of the free gingival margin buccally and lingually on all teeth to allow differentiation between supra- and subgingival calculus. A mucoperiosteal flap was raised and 2 of the remaining 4 unsealed teeth were scaled and root planed. The two remaining teeth were left unscaled and served as control.

Since no significant difference in effectiveness of scaling had previously been found among different types of teeth (Rabbani et al. 1981), any tooth type was deemed acceptable for use. Maxillary and mandibular incisors, cuspids, bicuspids and first and second molars, were included in the investigation. The total number of teeth was 127 (43 scaled, 42 flapped and 42 control teeth).

Measurements

Dental calculus was assessed according to the criteria of the PDI (Ramfjord 1967). The Marquis M-1 probe (Marquis Dental Manufacturing Company, Denver, Colorado 80206) was used for the detection of subgingival calculus.

Probing depth was measured from the free gingival margin to the bottom of the periodontal pocket. Measurements were made at 6 locations on each tooth (mesial-buccal, buccal, distal-buccal, distal-lingual, lingual and mesial-lingual) with the Marquis M-1 periodontal probe which was graduated at 3, 6, 8 and 11 mm.

The buccal and lingual measurements were made at the midline of the tooth, while all other measurements were made as close as possible to the interproximal contact areas of the teeth with the probe pointed in an axial direction. The measurements were rounded to the nearest mm; however, measurements close to 0.5 mm. were rounded to the lower whole number.

**Experimental protocol**

The experimental procedures were performed in the following order.

1. Review of the patient's medical history.
2. Calculus was scored according to the PDI (Ramfjord 1967).
3. The pocket depths were measured on the 6 surfaces of the experimental and control teeth.
4. Local anesthesia (2% lidocaine, 1:100,000 epinephrine) was administered by infiltration or block to anesthetize the teeth and gingiva.
5. The teeth were marked circumferentially at the level of the free gingival margin with the high speed handpiece and the inverted cone bur.
6. 2 of the experimental teeth were scaled and root planed thoroughly with hand instruments in an attempt to remove all supra- and subgingival plaque and calculus.
7. A buccal and lingual mucoperiosteal flap was raised relative to 2 of the remaining 4 teeth and the teeth were scaled and root planed thoroughly with hand instruments in an attempt to remove all supra- and subgingival plaque and calculus.
8. The teeth were extracted in the Oral and Maxillofacial Surgery Department at The University of Michigan School of Dentistry or in the Dental Service at the Veterans Administration Medical Center immediately after completion of the scaling and root planing of the flapped teeth.

**Preparation of teeth**

1. After the teeth were extracted, they were immediately rinsed with running water to remove surgical hemorrhage.
2. Soft tissue tags were removed.
3. The teeth were transferred to 1% methylene blue for 2 min. This solution stained the connective tissue attached to the teeth.
4. The teeth were rinsed with running water for 2 to 3 min.

**Assessment of calculus under a stereomicroscope**

The teeth were viewed under a stereomicroscope (J. M. Stereomicroscope, Olympus Optical Company, Ltd. Tokyo, Japan) with a magnification of 6.3/12.5. The calculus present was measured on 4 surfaces (buccal, lingual mesial and distal) using a Whipple Net Micrometer Disc (Micrometer Disc for Model J. M. Microscope, Olympus, Tokyo, Japan), 10mm x 10mm square subdivided into 100 squares, which was placed on the eyepiece of the stereomicroscope. The 4 surfaces were separated by placing a small scratch with a curette on each line angle of the tooth, from the areas of the gingival landmark (bur mark) to the line of the connective tissue attachment.

Based on the view in the stereomicroscope, the total number of squares, which covered each surface of the tooth from the connective tissue attachment to the free gingival margin scratch, were added. The number of squares with calculus, for each of the surfaces, were then counted and added. This represented the total number of squares with calculus. In the assessment of calculus, the presence of calculus in each square of the tenth grid was counted as one, even if it was seen as a very small piece or fragment (Rabbani et al. 1981).

**Statistical analysis**

MIDAS (Michigan Interactive Data Analysis System) was used to test the hypothesis that there was no difference in the affectiveness of subgingival scaling and root planing with or without a flap for access. The % of remaining calculus was compared among experimental groups in relation to pocket depth and tooth type.

The statistical test utilized to evaluate the data was the Z2 test.

When attempting to relate % calculus and pocket depth, the following modification was performed: The pocket depth was measured at 6 locations on each tooth. However, the % of calculus remaining was computed for 4 surfaces

| Table 1. %s of initial surface calculus scores and probing depths |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                | Calculus (PDI)  | Probing depth (mm) |
|                | 2   | 3   | 1-3 | 3-6 | >6  |
| scaling only   | 30.2% | 69.8% | 26.2% | 55.8% | 18.0% |
| scale with flap| 33.3% | 66.7% | 25.6% | 66.1% | 8.3%  |
| control        | 33.1% | 61.9% | 20.2% | 57.1% | 22.6% |
demonstrates that tooth type had no relationship to % of residual calculus faces which were scaled only. The $\chi^2$ test of residual calculus using only those surfaces against % is increased at deeper probing depths. The probability of leaving residual calculus probing depth in both instances. The scaled with a flap, indicates that the $\chi^2$ tests for surfaces scaled only, or faces from individual treatment groups. The % of residual calculus is dependent on between pocket depth and % of residual calculus. There is a highly significant relationship between calculus remaining after scaling only as compared to scaling with a flap ($P<0.0001$).

Table 2 shows the $\chi^2$ test comparing the % of residual calculus for these surfaces.

Table 2. Frequency distribution and % of residual calculus in the 3 groups

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>$N$</th>
<th>%</th>
<th>N</th>
<th>%</th>
<th>N</th>
<th>%</th>
<th>N</th>
<th>&gt;20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>scale</td>
<td>170</td>
<td>89</td>
<td>52.4%</td>
<td>33</td>
<td>19.4%</td>
<td>29</td>
<td>17.1%</td>
<td>19</td>
<td>11.2%</td>
</tr>
<tr>
<td>scale with flap</td>
<td>168</td>
<td>128</td>
<td>76.2%</td>
<td>21</td>
<td>12.5%</td>
<td>13</td>
<td>7.7%</td>
<td>6</td>
<td>3.6%</td>
</tr>
<tr>
<td>control</td>
<td>166</td>
<td>11</td>
<td>6.6%</td>
<td>8</td>
<td>4.8%</td>
<td>12</td>
<td>7.2%</td>
<td>135</td>
<td>81.3%</td>
</tr>
<tr>
<td>total</td>
<td>504</td>
<td>228</td>
<td>62</td>
<td>54</td>
<td>160</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2$: 309.59; significance: 0.00001.

of each tooth (buccal, lingual, mesial and distal) under the stereomicroscope. In order to make the pocket depth measurements and the calculus scores comparable for a given surface, the average of mesiobuccal and mesiolingual and also the average of distobuccal and distolingual pocket depth measurements were calculated and the means used for comparison with the calculus scores for these surfaces.

Results

The frequency distributions of initial PDI calculus scores (Ramfjord 1967) and probing depths are presented in Table 1.

Table 2 represents the frequency distribution and % of residual calculus for the 3 groups analyzed. Results show statistically significant differences between the 3 groups in the amount of residual calculus. A $\chi^2$ test was also performed comparing the % of residual calculus between the 2 treatment groups only. The results showed a statistically significant difference between calculus remaining after scaling only as compared to scaling with a flap ($P<0.0001$).

Table 3 shows the $\chi^2$ test comparing probing depth to % of residual calculus for both treatment groups tested. There is a highly significant relationship between pocket depth and % of residual calculus.

Table 4 relates probing depth and % of residual calculus related to probing depth for flapped surfaces

Table 3. Frequency distribution and % of residual calculus related to probing depths for treatment groups

<table>
<thead>
<tr>
<th>Probing depth</th>
<th>N</th>
<th>% residual calculus</th>
<th>0%</th>
<th>&gt;1%</th>
<th>Flapped</th>
<th>&gt;1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3 mm</td>
<td>87</td>
<td>75</td>
<td>22.2%</td>
<td>5</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>4-6 mm</td>
<td>206</td>
<td>125</td>
<td>37.0%</td>
<td>36</td>
<td>10.7</td>
<td>29</td>
</tr>
<tr>
<td>&gt;6 mm</td>
<td>45</td>
<td>17</td>
<td>5.0%</td>
<td>13</td>
<td>3.8</td>
<td>8</td>
</tr>
<tr>
<td>total</td>
<td>338</td>
<td>217</td>
<td>64%</td>
<td>54</td>
<td>3.8</td>
<td>158</td>
</tr>
</tbody>
</table>

$\chi^2$: 34.296; significance: 0.00001.

Table 4. Frequency distribution of residual calculus according to probing depth for scaled and flapped surfaces

<table>
<thead>
<tr>
<th>Probing depth</th>
<th>N</th>
<th>% residual calculus</th>
<th>0%</th>
<th>&gt;1%</th>
<th>Flapped</th>
<th>&gt;1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3 mm</td>
<td>89</td>
<td>81</td>
<td>91%</td>
<td>37</td>
<td>43.2</td>
<td>7</td>
</tr>
<tr>
<td>4-6 mm</td>
<td>128</td>
<td>84</td>
<td>66.4%</td>
<td>84</td>
<td>56.8</td>
<td>27</td>
</tr>
<tr>
<td>&gt;6 mm</td>
<td>128</td>
<td>84</td>
<td>21.4%</td>
<td>84</td>
<td>67.7</td>
<td>27</td>
</tr>
<tr>
<td>total</td>
<td>341</td>
<td>253</td>
<td>80%</td>
<td>128</td>
<td>67.7</td>
<td>52</td>
</tr>
</tbody>
</table>

$\chi^2$: 28.642; significance: 0.00001. $\chi^2$: 7.613; significance: 0.0222.

Table 5. Frequency distribution and % of residual calculus for scaled surfaces: anterior versus posterior

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>0%</th>
<th>% residual calculus</th>
<th>1-10%</th>
<th>11-20%</th>
<th>&gt;20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>anterior</td>
<td>92</td>
<td>49</td>
<td>28.8%</td>
<td>19</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>posterior</td>
<td>78</td>
<td>40</td>
<td>23.5%</td>
<td>14</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>total</td>
<td>170</td>
<td>89</td>
<td>33%</td>
<td>29</td>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2$: 1.3076; significance: 0.7273.

Table 6. Frequency distribution and % of residual calculus for flapped surfaces: anterior versus posterior

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>0%</th>
<th>% residual calculus</th>
<th>1-10%</th>
<th>11-20%</th>
<th>&gt;20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>anterior</td>
<td>84</td>
<td>61</td>
<td>36.3%</td>
<td>11</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>posterior</td>
<td>84</td>
<td>67</td>
<td>39.9%</td>
<td>10</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>total</td>
<td>168</td>
<td>128</td>
<td>21%</td>
<td>13</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2$: 3.0725; significance: 0.3806.
removing on teeth which are scaled without a flap. Table 6 shows the same test using only those surfaces which had been treated with a periodontal flap procedure. The results here are no different, since again, tooth type had no bearing on whether residual calculus remained following periodontal flap surgery.

Table 7 compares the number of surfaces with no residual calculus, with scaling only and scaling with a flap, in relation to probing depth. The χ² test reveals that the chance of removing all calculus is dependent on probing depth.

Fig. 1 shows the % of surfaces totally free of calculus for each group at the given levels of probing depths. Fig. 2 demonstrates the % of total surfaces for each experimental group according to the level of remaining calculus.

Discussion

Histological studies (Caton & Zander 1979, Waerhaug 1978a) have demonstrated that the healing of the dentoepithelial junction following subgingival plaque control resulted in the formation of a long junctional epithelium in areas previously covered with subgingival plaque and calculus. It has also been demonstrated that complete calculus removal is technically very difficult. Jones et al. (1972) root planed teeth in vivo until roots were smooth to an explorer. Subsequent examination with a scanning electron microscope revealed numerous residual calculus deposits. Saffert (1956) reported that teeth routinely scaled and root planed were found to have deposits remaining, especially in surface defects. Frumker et al. (1956) found retained calculus deposits on extracted teeth and concluded that, due to the topography of the root surface, it might be difficult to remove all calculus present. The findings of the present study are in agreement with the aforementioned authors.

Jones et al. (1972) described differences in the step height level of calculus deposits from the root surfaces and reported that these varied between 5 to 56 μm. In order to detect these deposits, every μm² of the surface would need to be explored. They concluded that once a surface had been instrumented, it was not always possible to differentiate clinically among calculus, cementum, and dentin. Rabbani et al. (1981) also noted that considerable amounts of calculus were found to be retained over areas judged clinically smooth. This result is in agreement with the present findings. In the present study, teeth were scaled and root-planed only, while another group of teeth were scaled and root-planed using periodontal flap surgery until the surfaces were judged clinically smooth to a periodontal probe or #17 explorer. Although there was a significantly greater reduction of residual calculus in the group using flap surgery over teeth scaled alone, in neither group was complete calculus removal attained for all surfaces.

Part of the rationale for periodontal flap surgery is to improve healing by facilitating access for, and subsequently achieving, a more thorough root planing. Waerhaug (1975) reported that following flap surgery for access, deposits were found which had been left near the bottom of the pocket. Reasons for failure of complete removal of deposits with flap surgery have been described as bleeding, which obscures the field of operation close to the bottom of the pocket, and the fact that the plaque front and the tooth are of the same color (Waerhaug 1978b). Although complete calculus removal was not accomplished on all surfaces with the flap procedure, the assessment of remaining calculus demonstrated that scaling in conjunction with a periodontal flap was significantly more effective than scaling and root-planing alone.

Rabbani et al. (1981) evaluated the effectiveness of subgingival scaling and root planing related to depth of pocket. Results of the study demonstrated a high correlation between % of residual calculus and probing depth on scaled and control teeth. Pockets less than 3 mm were the easiest sites for scaling and root planing, probing depths ranging from 3 to 5 mm were more difficult, and pockets deeper than 5 mm were the most difficult. This is in agreement with Waerhaug (1978b), who stated that in pockets less than 3 mm, success could be expected, but the chances of failure increased in 3 to 5 mm pockets, while with probing depths greater than 5 mm, the chances of failure dominated. The

<table>
<thead>
<tr>
<th>POCKET DEPTH</th>
<th>Scale only</th>
<th>Scale with flap</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3 mm</td>
<td>75</td>
<td>38 37</td>
</tr>
<tr>
<td>4-6 mm</td>
<td>125</td>
<td>42.7% 28.9%</td>
</tr>
<tr>
<td>&gt;6 mm</td>
<td>17</td>
<td>46.1% 65.6%</td>
</tr>
<tr>
<td>total</td>
<td>217</td>
<td>89 128</td>
</tr>
</tbody>
</table>

χ²: 8.603; significance: 0.0135.
present study demonstrated that this significant relationship between increased probing depth and increased % of surfaces with residual calculus existed not only on teeth treated by scaling alone, but also on teeth treated by flap surgery followed by scaling and root planing.

Rabbani et al. (1981) reported that in pockets less than 3 mm, complete calculus removal occurred in 75% of the teeth, but in pockets deeper than 3 mm, complete calculus removal occurred in only 18% of the teeth. Results from the present study demonstrated that in 1 to 3 mm pockets, 86% of all surfaces were completely cleaned of all deposits in both the scaled only group and the group in which a flap approach was used. This therefore demonstrates that in shallow 1 to 3 mm probing depths, scaling without flap surgery is just as beneficial in terms of calculus removal as scaling in conjunction with a flap.

However, the benefits of scaling with flap surgery become much more obvious in cases with deeper probing depths. In 4 to 6 mm pockets, only 43% of all surfaces were completely cleaned of all deposits on teeth which were scaled only, while 76% of all surfaces were completely cleaned in the teeth with flap surgery. In probing depths greater than 6 mm, the ratio of surfaces completely cleaned of all deposits was 32% for scaled only, versus 50% for those treated with flap surgery plus scaling and root planing. Although these ratios show a large number of surfaces with at least some amount of deposits remaining following flap surgery, many of these teeth, especially those with probing depths greater than 6 mm, were hopeless, with loss of attachment to the apex of the teeth. This made treatment difficult due to mobility, profuse bleeding, etc. Even so, scaling with a flap for access was significantly better than treatment with scaling and root planing alone in pockets deeper than 3 mm.

Rabbani et al. (1981) have reported that there was not a statistically significant difference in the % of residual calculus on different types of teeth. Findings in the present study agree with this observation in both the group treated by scaling with or without a flap.

The assessment of calculus demonstrated that the CEJ was probably the greatest area of calculus retention in the group treated with flap surgery. Grooves, fossae, and furcation areas also retained residual calculus, especially in the scaled only group. Another area of calculus retention was immediately below restorations, which was demonstrated in both treatment groups. Overall however, the scaled only group had more calculus retained on smooth surfaces as shown by the present results, while in the flapped group, remaining calculus was almost always associated with some sort of surface concavity.

Conclusions
Within the limits of this study, using a stereomicroscope to evaluate scaling effectiveness, the following conclusions can be drawn.

1. Periodontal flaps for access provide a means for greater reduction of residual calculus.
2. Periodontal flaps for access provide a means to achieve more tooth surfaces free of calculus in pockets >3 mm.
3. The % of residual calculus is related to probing depth, despite the treatment approach.
4. Anterior and posterior teeth respond similarly.

Zusammenfassung
Zahnsteinentfernung und Wurzelglättung mit und ohne parodontale Lappenchirurgie
References


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