PENETRATION DEPTHS WITH AN ULTRASONIC MINI INSERT COMPARED TO A CONVENTIONAL CURETTE IN PATIENTS WITH PERIODONTITIS AND IN PERIODONTAL MAINTENANCE

CHAPTER 6

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Periodontal root debridement is a vitally important component of surgical and nonsurgical therapy. The essential characteristic in the treatment of periodontitis is mechanical removal of subgingival bacterial deposits and calculus (Badersten et al. 1981; Lindhe et al. 1984; Waerhaug 1978). Traditionally this has been performed with manual instruments. Badersten et al. (1984) and Loos et al. (1987) demonstrated in their clinical studies that root debridement with hand instruments, ultrasonic and sonic scaler devices resulted in comparable clinical outcomes. In a review paper Drisko et al. (2000) concluded that ultrasonic and sonic scalers can achieve similar results as hand instruments for removing plaque, calculus and endotoxin. They also stated that due to the instrument width of the ultrasonic scalers furcations may be more easily accessible as compared to hand instruments.

Adequate access for subgingival debridement becomes more difficult as the probing depth increases (Caffesse et al. 1986; Dragoo 1992; Rateitschak-Pluss et al. 1992; Waerhaug 1978). Based on a SEM study Rateitschak-Pluss, et al. (1992) concluded that with hand instruments in many cases the base of a pocket will not be reached. In the past decades attempts have been made to facilitate ultrasonic debridement with tips of similar dimensions as a periodontal probe (Clifford et al. 1999; Dragoo 1992). Such ultrasonic inserts have been developed with the aim to safely improve subgingival root surface debridement using inserts with a thinner profile and/or longer shank. Dragoo (1992) reported that a modified and thinned ultrasonic insert might produce a greater depth of instrument efficiency as compared to standard ultrasonic inserts and universal hand curettes. This suggestion was supported by a study of Clifford et al. (1999) that compared standard P10 inserts (Dentsply) and a Slim-line tips (Dentsply). The results showed a trend towards deeper penetration of the Slim-line tips in deep pockets.

The degree of probe tip penetration is influenced by the presence of inflammation of the periodontal tissues. Even with relatively high forces the probe tip usually fails to reach the connective tissue attachment in healthy sites (Fowler et al. 1982) whereas already with minimal probing pressures, the probe tip generally stops at the level of intact connective tissue fibers or beyond in deep inflamed sites (Bulthuis et al. 1998). Consequently, when evaluating the penetration depth with instruments intended for subgingival root-surface debridement, the level of periodontal health should be taken into account.
The aim of the study was to test whether a slim ultrasonic insert reaches a more apical position when penetrating a periodontal pocket compared to the working blade of a conventional Gracey curette in both untreated periodontitis and periodontal maintenance patients.

Material and Methods

Patients

Two groups of patients were selected for the study. One group consisted of 20 untreated periodontitis patients and another of 15 periodontal maintenance patients. All patients had an initial diagnosis of moderate to advanced periodontitis, on the basis of manual probing depth measurements and radiographs.

The 15 periodontal maintenance patients had received initial periodontal therapy consisting of instruction in plaque control measures, supra-/subgingival debridement and periodontal surgery when needed. Following the active treatment they were enrolled in a 3 to 4 monthly maintenance protocol during a period of at least 1 year. The patients were selected on the presence of at least one site a pocket of ≥ 5mm in each quadrant (preferably premolars and molars). All eligible subjects were given oral and written information about the purpose of the study. After screening for suitability, they were requested to give their written informed consent to qualify for enrolment. The study was carried out in accordance with the ethical guidelines of the “Declaration of Helsinki”.

Force controlled probe (Fig. 1)

For the reference probing pocket depth the Jonker Probe® (Jonkers Data, Staphorst, Netherlands) was used. It has a tapered tine with a diameter at the tip of 0.5 mm increasing to 0.6 mm at the 5 mm and 0.7 mm at the 10 mm marking. The probing force of Jonker Probe was 0.30 N, achieving a probing pressure of 153 N/cm² (Barendregt et al. 2006).
POCKET PENETRATION AND SUBGINGIVAL DEBRIDEMENT

Fig 1. From top to bottom 1) Gracey curette (Hu Friedy Gracey After Five Vision curette), 2) EMS PS Ultrasonic tip and 3) Tip of the Jonker Probe®

**Instruments used (Fig. 1)**

a) *EMS PS Ultrasonic tip (EMS Company Geneva Switzerland)*; a slim perio tip (PS) was used. This is a flat tapered tip with a width of 0.39 mm at the tip increasing to 0.66 mm at the 5 mm marking and 1.02 mm at the 10 mm. With help of a laser beam calibration markings were made at 4, 6, 7, 8, 9, 10 mm.

b) *Gracey curette (Hu Friedy Gracey After Five Vision curette; Hu-Friedy, Chicago, USA)*; the After 5 curette has a diameter of 0.7 mm at 1 mm (just above the working surface increasing to 0.84 mm at the 5 mm marking an 1.21 mm at the 10 mm marking. The Vision curettes already have markings made at 5 and 10 mm so additional markings were positioned at the 3, 6, 7, 8, 9 and 11 mm locations.

The accuracy of the calibration was verified with a magnifying glass with mm calibration marks.

**Experimental sites**

For this study a design was adapted from Barendregt et al. (2006). In each patient of the periodontitis group and the maintenance group, 4 teeth (preferably premolars or molars) showing at least at one site a pocket of ≥ 5mm, were included in the study based on pre-screening measurements with a
conventional manual probe with Williams markings. These experimental teeth were equally
distributed between the arches and included shallow (<4mm), moderate (≥4 and <7mm) and deep
sites (≥7mm) (Table 1). At each experimental tooth 4 sites were selected which resulted in 320 sites in
the periodontitis group and in 240 evaluable sites for the maintenance group in this study. In order to
minimize the effect of bias as a result of intra-examiner reproducibility, 2 experienced clinicians
performed the measurements in both parts of this study. Each examiner was unaware of the probing
pocket depth at screening.

Clinical procedures

First, using the Jonker Probe, the probing pocket depth recordings were made at the distobuccal (DB),
mesiobuccal (MB), distolingual (DL) and mesiolingual (ML) sites at the 4 experimental teeth in each
patient. The clinical examiner was unable to see the electronic display and therefore unaware of the
probing pocket depth. Secondly both the calibrated Hu-Friedy Gracey After Five curette and the EMS
PS slim Ultrasonic Tip were used in a randomized order in both patient groups to determine pocket
penetration depth. With the Ultrasonic Tip and the Gracey Curette the recordings were rounded off to
the nearest whole millimeter. The Jonker Probe, Gracey Curette and Ultrasonic Tip were inserted
parallel to the root in contact with the surface and directed apically towards the perceived location of
the apex of the root.

Data analysis

Analysis of probing measurements for the different devices was performed using the site as the unit
of measurement. Differences in measuring results between Jonker Probe, Ultrasonic Tip and Gracey
Curette were tested by use of a mixed model analysis of variance corrected for examiner and patient
effects. To test for systematic differences between sessions paired Student t-test were used. P-
values of <0.05 were accepted as statistically significant.
POCKET PENETRATION AND SUBGINGIVAL DEBRIDEMENT

Results

Table 1 shows the mean probing depths at screening and selection with the manual probe at site level for both groups. For the periodontitis group of the selected sites, 20 sites were excluded from the analysis due to technical difficulties during the clinical procedures. Therefore the mean screening probing depths (manual probe) were calculated over 300 sites in the periodontitis group and amounted to 6.11 mm with a range between 3.00 and 10.00 mm. The mean results were subdivided into shallow (<4mm), moderately deep (≥4 and <7mm) and deep sites (≥7mm). The proportion of the shallow group was 3%, moderate deep sites 57% and deep sites 40%. In the maintenance group 240 sites were available for evaluation. The mean probing depth based on the manual screening probing measurements was 5.26 mm with a range of 1.00 to 9.00 mm. The proportion of the shallow sites in this group was higher as compared to the periodontitis group to 17%. This was also true for the moderate deep pockets (59%). The proportion of deep pockets was lower in the maintenance group (24%).

Table 1. Characteristics of the experimental sample

<table>
<thead>
<tr>
<th>Screening pocket depth</th>
<th>No. surfaces</th>
<th>Mean pocket probing depth (SD)</th>
<th>Range</th>
<th>Premolars</th>
<th>Molars</th>
<th>Cuspids</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 3 mm</td>
<td>9</td>
<td>3.00 mm (0.00)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-6 mm</td>
<td>169</td>
<td>5.01 mm (0.76)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ 7 mm</td>
<td>122</td>
<td>7.88 mm (1.11)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All sites</td>
<td>300</td>
<td>6.11 mm (1.76)</td>
<td>3-10 mm</td>
<td>43%</td>
<td>52%</td>
<td>5%</td>
</tr>
<tr>
<td>≤ 3 mm</td>
<td>40</td>
<td>2.38 mm (0.66)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-6 mm</td>
<td>142</td>
<td>5.07 mm (0.77)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ 7 mm</td>
<td>58</td>
<td>7.40 mm (0.59)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All sites</td>
<td>240</td>
<td>5.26 (1.62)</td>
<td>1-9 mm</td>
<td>41.5%</td>
<td>58%</td>
<td>0.5%</td>
</tr>
</tbody>
</table>
The results for the untreated periodontitis group are presented in Table 2. The mean probing depth as established with the Jonker Probe was 5.62 mm. The mean penetration depth with the Ultrasonic Tip was significantly deeper as compared to the probing pocket depth assessed with the Jonker Probe and the Gracey Curette. The penetration depth with the Gracey Curette did not differ from the Jonker Probe. The Gracey Curette however penetrated significantly less deep than the Ultrasonic Tip.

Table 2. Mean pocket depths for the Jonkers Probe and penetration depths Ultrasonic Tip and Gracey Curette in the untreated periodontitis.

<table>
<thead>
<tr>
<th></th>
<th>All sites</th>
<th>&lt;4mm</th>
<th>≥4&lt;7mm</th>
<th>≥7mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 300</td>
<td>n = 9</td>
<td>n = 169</td>
<td>n = 122</td>
<td></td>
</tr>
<tr>
<td><strong>Jonker Probe</strong> (JP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>5.62</td>
<td>3.00</td>
<td>5.04</td>
<td>6.68</td>
</tr>
<tr>
<td>SD</td>
<td>1.65</td>
<td>0.50</td>
<td>1.34</td>
<td>1.43</td>
</tr>
</tbody>
</table>

| **Ultrasonic Tip** (UT) |           |      |        |      |
| Mean                   | 6.91<sup>a,b</sup> | 3.89<sup>a,b</sup> | 6.13<sup>a,b</sup> | 8.25<sup>a,b</sup> |
| SD                     | 1.87      | 0.60 | 1.49   | 1.52 |

| **Gracey curette (GC)** |           |      |        |      |
| Mean                   | 5.60      | 3.22 | 4.97   | 6.74 |
| SD                     | 1.70      | 0.66 | 1.36   | 1.47 |

<sup>a</sup> significant difference with the Jonker probe *p* < 0.05
<sup>b</sup> significant difference with the Gracey curette *p* < 0.05

Also, when subdividing the measurements into shallow, moderate and deep sites, comparable results were found. In the maintenance patients no significant differences between the Jonker Probe, the Ultrasonic Tip and the Gracey Curette were found (Table 3).

Table 3. Mean pocket depth for the Jonkers Probe and penetration depth for the Ultrasonic Tip and Gracey Curette in the maintenance group.

<table>
<thead>
<tr>
<th></th>
<th>All sites</th>
<th>&lt;4mm</th>
<th>≥4&lt;7mm</th>
<th>≥7mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 240</td>
<td>n = 41</td>
<td>n = 169</td>
<td>n = 122</td>
<td></td>
</tr>
<tr>
<td><strong>Jonker Probe</strong> (JP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>3.92</td>
<td>2.50</td>
<td>3.89</td>
<td>5.01</td>
</tr>
<tr>
<td>SD</td>
<td>1.58</td>
<td>0.86</td>
<td>1.23</td>
<td>1.91</td>
</tr>
</tbody>
</table>

| **Ultrasonic Tip** (UT) |           |      |        |      |
| Mean                   | 3.85      | 2.56 | 3.74   | 5.04 |
| SD                     | 1.94      | 1.18 | 1.76   | 2.15 |

| **Gracey curette (GC)** |           |      |        |      |
| Mean                   | 3.85      | 2.39 | 3.79   | 5.04 |
| SD                     | 2.05      | 1.09 | 1.70   | 2.60 |
For comparison of the penetration depth assessed in the periodontitis group and the maintenance group for the Ultrasonic Tip and the Gracey Curette, the mean difference with the reference probing pocket depth of the Jonker Probe was calculated (Table 4). No significant differences were found between the penetration depths of the Gracey Curette in the untreated periodontitis group and the maintenance group for all sites. Neither the comparisons in the subcategories provided a significant difference for the Gracey Curette. However, the comparison of the penetration depths as assessed with the Ultrasonic Tip showed in both groups significant differences. Not only at all sites the Ultrasonic Tip reached a more apical level in the periodontitis group but also in the subcategories shallow, moderate and deep sites (Table 4).

*Table 4.* The mean difference (mm) of pocket probing depth with the Jonkers Probe (PPD) and the penetration depth (PD) assessed with the Ultrasonic Tip or the Gracey Curette

<table>
<thead>
<tr>
<th>Screening pocket depth</th>
<th>Ultrasonic Tip</th>
<th>Gracey Curette</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Untreated Periodontitis</td>
<td>Maintenance Group</td>
</tr>
<tr>
<td>≤ 3 mm</td>
<td>-0.89 (0.60)</td>
<td>0.06 (1.15)</td>
</tr>
<tr>
<td>4-6 mm</td>
<td>-1.09 (1.06)</td>
<td>0.15 (1.86)</td>
</tr>
<tr>
<td>≥ 7 mm</td>
<td>-1.57 (1.07)</td>
<td>-0.02 (2.77)</td>
</tr>
<tr>
<td>All sites</td>
<td>-1.28 (1.08)</td>
<td>0.07 (2.02)</td>
</tr>
</tbody>
</table>

*Significant difference with the UT (Maintenance Group) p< 0.05*

**Discussion**

Previous research suggested that in case of untreated periodontitis thin ultrasonic inserts penetrate pockets of ≥ 4 mm deeper as compared to standard ultrasonic inserts and manual curettes (Dragoo 1992, Clifford et al. 1999). In the present study a slim ultrasonic insert and a conventional manual curette were tested for their ability penetrate periodontal pockets. In order to evaluate these instruments in both shallow and deep pockets that have a relative healthy or inflamed condition,
untreated periodontitis patients and periodontal maintenance patients that showed presence of pockets ≥ 5 mm were selected. For reference measurements the Jonker Probe was used assessing the probing depth with a probing pressure of 153 N/cm$^2$. Based on the existing literature (Garnick et al. 1980; Hancock et al. 1981; Van der Velden et al. 1981; Fowler et al. 1982; Bulthuis et al. 1998) it is presumed that in the periodontitis group the probe tip of the Jonker Probe, employing this relatively low probing pressure, stops at the connective tissue attachment level. With higher pressures the probe will stop on average 0.45 to 0.80 mm apically to the connective tissue attachment level (Fowler et al. 1982; Bulthuis, et al. 1998). In the periodontitis group the Ultrasonic Tip reached significantly deeper in all categories of pockets depths than the Jonker Probe. This could be the result of differences in probing forces and consequently probing pressures. It is well known that a wide range of probing forces are employed during manual probing varying between 0.2 and 1.3 N, however most clinicians used a probing force higher than 0.3 N (Hassell, et al. 1973). Therefore it is likely that the Ultrasonic Tip of the present study, being comparable in size and shape to the Jonker Probe probe, is used with higher forces than the 0.3 N of the Jonker Probe. This will have resulted in higher probing pressures and consequently deeper probing measurements. Since the tip of the Jonker Probe, when using 0.3 N probing force, is on average located at the connective tissue attachment level in untreated periodontitis, the Ultrasonic Tip must have been located apically to the attachment level. The finding of no differences in penetration depth between the Jonker Probe and the Gracey Curette does suggest that the probing pressure of these instruments is comparable. Since the “probing surface” of a Gracey Curette is on average 4 times larger than that of the Jonker Probe, a probing pressure of approximately 1 N must be used in order to exert a comparable probing pressure as that of the Jonker Probe. Therefore it is not surprising to find in the present study that the tip of Gracey Curette is not located apically to the attachment level since probing forces larger than 1 N should have been employed.

Another aspect of the deeper penetration of the Ultrasonic Tip compared to the Gracey Curette in untreated periodontitis patients is the effectiveness of the instruments in the most apical parts of pockets. It may be supposed that in this respect the present Ultrasonic Tip performs better than the Gracey Curette. This suggestion is in agreement with Gagnon et al. (2004) who compared the effectiveness of curettes, regular ultrasonic inserts and ultrasonic mini-inserts on extracted teeth. They showed in all cases that the mini-inserts allowed greater apical access. They concluded that the shape of the mini-inserts made them more effective in apical zones. Obviously this applies for deep inflamed
pockets. In maintenance patients the pockets have been scaled in the past and are therefore less inflamed. In such pockets the tip of the Jonker Probe, when using 0.3 N, will be located coronal to the connective tissue attachment (Van der Velden 1981, Fowler et al. 1982). Since no differences were found in penetration depth between the Jonker Probe and the Ultrasonic Tip and the Gracey Curette respectively, the tip of both instruments will be located coronal to the attachment level. This phenomenon is most likely due to the tonus of the gingival tissues surrounding the teeth. Beardmore (1963) showed that the tonus of the gingival tissues increases as the signs of inflammation decrease. Accordingly in the relatively healthy sites in the maintenance group, it seems that the advantage of easier penetration of the Ultrasonic Tip was neutralized by higher tissue tonus of the marginal gingival tissues. It remains to be investigated however, whether the observed penetration of the Ultrasonic Tip and the Gracey Curette when used as a probe, is comparable to penetration whilst performing subgingival debridement in both untreated periodontitis and maintenance patients. One can speculate the pocket penetration may increase when instrumentation force is applied on the gingival tissues.

Since the removal of the biofilm is the main objective in periodontal maintenance patients, the minimal loss of tooth substance with an ultrasonic scaler as compared to a conventional manual curette (Schmidlin et al. 2001), is an important parameter to be taken into account in this patient group.

Several studies have reported a loss of probing attachment following scaling and rootplaning (Badersten, et al. 1981; Badersten et al. 1984; Claffey et al. 1988; Lindhe et al. 1982). Claffey et al. (1988) showed for moderate to deep pockets a mean loss of 0.5 to 0.6 mm. After 12 month the clinical attachment levels for the majority of these sites seemed to rebound with a gradual gain. The initial loss of clinical attachment as a result of instrumentation was again confirmed by Alves et al. (2005) for hand instruments but also for ultrasonic scalers.

Based on measurements with a Florida Probe set at 0.25 N performed immediately after subgingival debridement, a comparable mean loss of 0.73 mm for the Gracey curette and 0.78 mm for the ultrasonic scaler was shown. Izumi et al. (1999) deliberately tried to avoid trauma to the most coronal part of the connective tissue attachment by inserting the curettes 1 mm shallower than the probing pocket depth. Their results showed no significant differences between the test (curette 1 mm short of the bottom of the pocket) and the control teeth with regard to probing pocket depth and mean probing attachment level at 1 and 3 months following treatment. They stated that compared to
effective removal of subgingival deposits, trauma to the most coronal part of the connective tissue and remodeling of the lesion in that area following scaling and root planning is of minor importance. Therefore the deeper penetration of the Ultrasonic Tip when used during debridement might induce a risk for greater trauma to the coronal connective tissue attachment than the Gracey Curette but that appears not to be a major factor in the clinical treatment outcome.

In conclusion, the results of present study show that in untreated periodontitis patients the slim Ultrasonic Tip penetrated the pocket to deeper depths than the pressure controlled probe and the Gracey Curette. In periodontal maintenance patients with relatively healthy gingivae the pocket penetration was not statistically different.

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References


