Probing Bone Level Measurements for Determination of the Depths of Class II Furcation Defects

Youngil Suh

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Probing Bone Level Measurements for Determination of the Depths of Class II Furcation Defects

by

Youngil Suh

A Thesis submitted in partial satisfaction of the requirements for the degree Master of Science in Periodontics

June 2001
Each person whose signature appears below certifies that this thesis in his opinion is adequate, in scope and quality, as a thesis for the degree Master of Science.

Max Crigger, Professor

Gary Bogle, Associate Professor

Bernard Gantes, Associate Professor, Clinical Director

Matt Riggs, Professor
ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS .................................................. v
LIST OF TABLES ................................................................. vi
ABSTRACT ............................................................................... 1

CHAPTER ONE
I. INTRODUCTION ............................................................... 3

CHAPTER TWO
II. MATERIALS AND METHODS ........................................... 4
   A. Patients .................................................................. 4
   B. Experimental Procedures ......................................... 4
   C. Data Analysis .......................................................... 5
III. RESULTS ........................................................................ 7
IV. DISCUSSION .................................................................. 8

CHAPTER THREE
V. REFERENCES ................................................................. 24
<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a. Illustration of vertical measurement using the CP-15UNC straight probe from a buccal view</td>
<td>12</td>
</tr>
<tr>
<td>1b. Illustration of vertical and horizontal measurements using the CP-15UNC straight probe and the Hu-Friedy curved probe a proximal view</td>
<td>15</td>
</tr>
<tr>
<td>2. Specially designed 20 mm curved probe</td>
<td>14</td>
</tr>
<tr>
<td>3. Vertical measurements made with CP-15UNC straight probe</td>
<td>15</td>
</tr>
<tr>
<td>3a. Vertical probing attachment measurement</td>
<td>15</td>
</tr>
<tr>
<td>3b. Vertical probing bone level measurement</td>
<td>16</td>
</tr>
<tr>
<td>3c. Vertical open bone measurement</td>
<td>17</td>
</tr>
<tr>
<td>4. Horizontal measurements made with 20 mm curved probe</td>
<td>18</td>
</tr>
<tr>
<td>4a. Horizontal probing attachment measurement</td>
<td>18</td>
</tr>
<tr>
<td>4b. Horizontal probing bone level measurement</td>
<td>19</td>
</tr>
<tr>
<td>4c. Horizontal open bone measurements</td>
<td>20</td>
</tr>
<tr>
<td>Table</td>
<td>Page</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>1. Frequencies (number of sites) for deviations of recordings of different magnitude between 1\textsuperscript{st} and 2\textsuperscript{nd} examiners for vertical and horizontal measurements (buccal and lingual defects combined). Mean differences and standard deviations for pairs of duplicate recordings. Pearson coefficient of correlation (r) between recordings by 1\textsuperscript{st} and 2\textsuperscript{nd} examiners</td>
<td>21</td>
</tr>
<tr>
<td>2. Standard deviations of differences between pairs of duplicate recordings by 1\textsuperscript{st} and 2\textsuperscript{nd} examiners</td>
<td>22</td>
</tr>
<tr>
<td>3. Differences (means \pm S.D. and ranges) within vertical and horizontal measurements for 1\textsuperscript{st} and 2\textsuperscript{nd} examiners (buccal and lingual defects combined)</td>
<td>23</td>
</tr>
</tbody>
</table>
ABSTRACT OF THE THESIS

Probing Bone Level Measurements for Determination of the Depths of Class II Furcation Defects

by

Youngil Suh

Master of Science, Graduate Program in Periodontics
Loma Linda University, June 2001
Dr. Max Crigger, Director

Background: Probing bone measurements as an alternative to open bone measurements to evaluate regenerative procedures in furcation defects do not seem to have been used as of yet. The purpose of the present study was to investigate the reliability of probing bone measurements in such defects.

Methods: 15 patients scheduled for surgical treatment of a total of 30 mandibular 1st or 2nd molars with buccal or lingual class II furcation defects were studied. During treatment, duplicate vertical and horizontal recordings of probing attachment levels, probing bone levels and open bone levels were taken by independent examiners.

Results: Deviations of both vertical and horizontal recordings between 1st and 2nd examiners were within ±1 mm in 90–100% of examined sites for all 3 measurements. Standard deviations of differences between pairs of duplicate recordings were also similar for the 3 measurements, both for vertical and horizontal defect dimensions, and amounted to 0.7-0.9 mm. On average, vertical and horizontal open bone levels were 0.9-
1.1 mm deeper than probing bone levels. Probing bone levels, in turn, were 1.1-1.5 mm deeper than probing attachment levels.

Conclusions: In view of the consistency demonstrated between probing bone level and open bone level measurements in mandibular class II defects, coupled with the additional discomfort for the patient of a re-entry surgery and a possible re-entry traumatic effect, open bone level measurements do not seem necessary or even justified to evaluate effects of periodontal therapy in these defects, and can be substituted by probing bone measurements.
INTRODUCTION

The results of clinical studies on regenerative periodontal therapy are often evaluated from a combination of soft and hard tissue measurements (for reviews see Garrett¹ and Egelberg²). Commonly, bone levels measured during surgical procedures are compared to levels recorded at surgical re-entry 6-12 months later. In order to avoid surgical re-entry for measurement purposes, probing bone level measurements (‘bone sounding’) have been introduced and found to be reliable for determination of bone fill in intraosseous defects.³⁴ Several regenerative studies of such defects have relied on probing bone level measurements.⁵⁻¹³

Probing bone level measurements for evaluation of regenerative procedures in furcation defects do not seem to have been used in clinical studies as of yet. Mealey et al.¹⁴, however, demonstrated that the concordance (-1, 0, +1 mm agreement) between probing bone and open bone measurements in furcations defects was 86% for vertical depth measurements and 84% for horizontal depth measurements. The purpose of the present study was to further investigate the use of probing bone measurements in these defects.
MATERIALS AND METHODS

Patients

15 patients (6 males, 9 females) scheduled for surgical treatment of mandibular 1st or 2nd molars with buccal or lingual class II furcation defects in the Advanced Periodontics Clinic at Loma Linda University were chosen as subjects. Patients ranged in age from 28 to 69 years.

A total of 30 furcation defects were studied (1 defect in 3 patients; 2 defects in 10 patients; 3 defects in 1 patient; and 4 defects in 1 patient), 16 buccal and 14 lingual, all having a minimum horizontal probing depth of 3 mm. The scheduled treatment was either an open surgical debridement or a regenerative procedure, as determined at re-evaluation following initial periodontal therapy. All surgical procedures were performed by one and the same operator (author Y-I. S.). Recordings for this study were obtained during the course of the surgical treatments and following prior receipt of informed consent from the patients. Approval for the study was granted by the Institutional Review Board at Loma Linda University.

Experimental Procedures

Measurements of probing attachment levels were taken before the administration of local anesthesia. Probing bone level measurements were obtained immediately following local anesthesia by forcing the probe through the soft tissues until definite resistance was met. Open bone measurements were carried out after surgical exposure and removal of soft tissues in the defects.
All recordings of the defects were obtained in both vertical and horizontal
directions, first by one examiner (1<sup>st</sup> examiner, author Y-I. S.), followed by independent
measurements by a 2<sup>nd</sup> examiner. The 2<sup>nd</sup> examiner was alternated among 3 investigators
throughout the study, each examining approximately 1/3 of the defects (authors M.C.,
T.L. and T.S.).

Reference points for both horizontal and vertical measurements were provided by
the use of stents made of self-curing clear resin. Each stent had prominent extensions
with a vertical groove to guide probe placement (Fig. 1). The edge of the stent was
blackened to facilitate reading the measurements.

Vertical measurements were obtained using a 15 mm periodontal probe with 1 mm
increments and a probe tip diameter of 0.4 mm*. Horizontal measurements were taken
using specially designed 20 mm curved probes*, also with 1 mm increments and a probe
tip diameter of 0.4 (Fig. 2). Standardized probing force was not used. Readings to the
deepest vertical and horizontal locations were obtained using guidance provided by the
extension of the stents and the apertures and domes of the furcations (Fig. 3 and 4).

Data Analysis
The degree of reproducibility of the measurements of probing attachment levels,
probing bone levels and open bone levels was determined by comparison of recordings
by 1<sup>st</sup> and 2<sup>nd</sup> examiners. The frequencies of deviations of recordings of different
magnitude between the examiners were determined. Standard deviations of the difference
between the pairs of duplicate recordings were calculated. Computations were made for
all defects, as well as separate for buccal and lingual defects. Differences between standard deviations were evaluated using Hartley’s $F$-max test for homogeneity of variance.

Differences in the recorded depths of the defects between the measurements of probing attachment level, probing bone level and open bone level were also determined.

* University of North Carolina (CP-15UNC), Hu-Friedy Mfg. Co., Chicago, IL, USA
† Hu-Friedy Mfg. Co., Chicago, IL, USA
RESULTS

The degree of reproducibility of the measurements of probing attachment levels, probing bone levels and open bone levels for buccal and lingual defects combined is presented in Table 1. Deviations of both vertical and horizontal recordings between 1st and 2nd examiners were within ±1 mm in 90–100% of the examined sites for all 3 measurements. The standard deviations of the differences between the pairs of duplicate recordings by 1st and 2nd examiners were also similar for the 3 different measurements, both for vertical and horizontal defect dimensions, and amounted to 0.7-0.9 mm. No statistically significant differences were found between the standard deviations for vertical versus horizontal measurements. Recordings taken by 2nd examiners were generally somewhat deeper than measurements by 1st examiner.

The standard deviations of the differences between the pairs of duplicate recordings by 1st and 2nd examiners separate for buccal and lingual defects are presented in Table 2. No statistically significant differences were found between the standard deviations for buccal versus lingual recordings for either vertical or horizontal measurements.

Differences in the recorded depths of the defects between the measurements of probing attachment level, probing bone level and open bone level for both 1st and 2nd examiners are presented in Table 3. On average, vertical and horizontal open bone levels were 0.9-1.1 mm deeper than probing bone levels. Probing bone levels, in turn, were 1.1-1.5 mm deeper than probing attachment levels.
DISCUSSION

The reproducibility of the measurements in this study was evaluated by comparing the duplicate recordings taken by the 1st and 2nd examiners. Comparisons of duplicate pairs allow the determination of the concordance of the measurements, i.e. the frequency of identical recordings versus measurement with a differences of 1, 2, or more mm between the pairs. We also used the standard deviations of the differences between the pairs of duplicate recordings by the 1st and 2nd examiners to determine the degree of reproducibility.

The findings of the present study indicate that the reproducibility of measurements of vertical and horizontal probing bone levels in class II furcation defects is comparable to the reproducibility of corresponding measurements of probing attachment levels and open bone levels. In addition, the overall degree of reproducibility for the 3 measurements in the present study (90-100% of measurements within +/- 1 mm; standard deviations ranging from 0.7 to 0.9) compares well with that of corresponding measurements in the studies on furcation defects by Mealey et al.\textsuperscript{14} and Eickholtz & Kim\textsuperscript{15}, in a study using random surgical sites by Kim et al\textsuperscript{17} and in a study on intraosseous defects by Renvert et al.\textsuperscript{3} Thus, recordings of vertical and horizontal probing bone levels in class II furcation defects seem to be as reliable as other periodontal probe measurements.
The 1st examiner of the present investigation was one and the same individual throughout the study. The 2nd examiner was alternated between 3 periodontists due to practical reasons. Regrettably, due to the limited number of defects, separate comparisons of reproducibility for each of the 2nd examiners to the 1st examiner could not be performed.

A curved probe was devised for the horizontal measurements of the present study. The extensions mounted on the stents were designed in such a way that they could be used as reference points for both the vertical and horizontal measurements of the furcation defects. This omitted manufacture of separate stents for the vertical and horizontal measurements. It should be realized, however, that the readings of the horizontal measurements from the edge of the stent may not represent accurate millimeters due to the geometry involved when using a curved probe. A change in horizontal defect depth of 1 mm at the tip of the curved probe may be reflected by a smaller change than 1 mm at the edge of the stent.

A curved probe, compared to a straight probe, facilitates horizontal access to the furcation area during probing. Access is influenced by the position of the gingival margin relative to factors including the root trunk length, sloping of the fornix aperture, and shape of the roof of the furcation dome. The use of a straight probe may not allow adequate access in certain situations, which influenced our selection of a curved probe for the horizontal measurements.
On average, vertical and horizontal open bone levels were found to be 0.9-1.1 mm deeper than probing bone levels. These differences are greater than what was observed in furcation defects by Mealey et al.\textsuperscript{14}, who found average differences of 0.4-0.5 mm. For intraosseous defects, Renvert et al.\textsuperscript{3} found that vertical open bone levels were on average 0.3 mm deeper than probing bone levels, Ursell\textsuperscript{16} found a corresponding difference of 0.9 mm, and Zybutz et al.\textsuperscript{4} a difference of 0.1 mm. Kim et al.\textsuperscript{17} a difference of 0.2. The discrepancy between open bone levels and probing bone levels is most likely explained by unintentional removal of bone during the soft tissue curettage of the lesions. The greater discrepancy between these 2 measurements in the present study than in the other reports is most likely explained by a more ambitious curettage by the operator of the present study.

The present study did not compare the results of regenerative treatment using probing bone levels versus open bone levels, i.e. measurements taken both before therapy and at the completion of the healing phase, followed by a comparison of the changes due to therapy by the 2 methods. As such, the findings reported here are limited to presurgical diagnostic measurements. However, there is little reason to believe that the conditions of the osseous tissues before therapy and at the completion of the healing phase would be different. The relationship between the 2 measurements would seem to be the same at these 2 time points. We are therefore suggesting that the findings of this study indicate that probing bone level measurements can be used as a substitute for open bone levels in regenerative studies of class II furcation defects.
As mentioned above, the finding that the open bone level measurements generally exceeded the probing bone level measurements is probably explained by the fact that some bone is removed during the soft tissue curettage prior to taking the open measurement. This supports the notion that newly formed bone following regenerative treatment may be at risk for traumatic removal with the open bone measurements. Prudent patient management may contradict a re-entry procedure that feasibly compromises the outcome of osseous wound healing.

In conclusion, in view of the consistency demonstrated between probing bone level and open bone level measurements in mandibular class II defects, coupled with the additional discomfort for the patient of a re-entry surgery and a possible re-entry traumatic effect, open bone level measurements do not seem necessary or even justified to evaluate effects of periodontal therapy in these defects, and can be substituted by probing bone measurements.
Figure 1a. Illustration of vertical measurement using the CP-15UNC straight probe from a buccal view.
Figure 1b. Illustration of vertical and horizontal measurements using the CP-15UNC straight probe and the specially designed curved probe from a proximal view.
Figure 2. Specially designed 20mm curved probe. Pair for left and right measurements.
Figure 3. Vertical measurement made with 15 mm UNC probe.
3a. Vertical probing attachment level measurement.
Figure 3b. Vertical probing bone level measurement
Figure 3c. Vertical open bone level measurement
Figure 4. Horizontal measurements made with 20 mm curved probe.
4a. Horizontal probing attachment level measurement.
Figure 4b. Horizontal probing bone level measurement.
Figure 4b. Horizontal probing bone level measurement.
Figure 4c. Horizontal open bone level measurement
Table 1.

Frequencies (number of sites) for deviations of recordings of different magnitude between 1st and 2nd examiners for vertical and horizontal measurements (buccal and lingual defects combined). Mean differences and standard deviations for pairs of duplicate recordings.

<table>
<thead>
<tr>
<th>Deviation (mm)</th>
<th>Probing Attachment Level</th>
<th>Probing Bone Level</th>
<th>Open Bone Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vertical Measurements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+2</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>+1</td>
<td>8</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>0</td>
<td>11 (97%)</td>
<td>11 (93%)</td>
<td>11 (90%)</td>
</tr>
<tr>
<td>-1</td>
<td>10</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>-2</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>mean diff. = 0.00</td>
<td>mean diff. = +0.37</td>
<td>mean diff. = +0.47</td>
<td></td>
</tr>
<tr>
<td>S.D. = 0.87</td>
<td>S.D. = 0.85</td>
<td>S.D. = 0.86</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Horizontal Measurements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>+1</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>0</td>
<td>15 (100%)</td>
<td>16 (100%)</td>
<td>11 (93%)</td>
</tr>
<tr>
<td>-1</td>
<td>6</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>-2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>mean diff. = +0.10</td>
<td>mean diff. = +0.13</td>
<td>mean diff. = +0.17</td>
<td></td>
</tr>
<tr>
<td>S.D. = 0.71</td>
<td>S.D. = 0.68</td>
<td>S.D. = 0.91</td>
<td></td>
</tr>
</tbody>
</table>

* + sign indicates that measurements of 2nd examiner is deeper than that of 1st examiner

† Number of deviating sites
Table 2.
Standard deviations of differences between pairs of duplicate recordings by 1\textsuperscript{st} and 2\textsuperscript{nd} examiners separate for buccal and lingual defects

<table>
<thead>
<tr>
<th>Defects</th>
<th>Vertical probing attachment level</th>
<th>Vertical probing bone level</th>
<th>Vertical open bone level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buccal</td>
<td>±0.81</td>
<td>±0.72</td>
<td>±0.70</td>
</tr>
<tr>
<td>Lingual</td>
<td>±0.95</td>
<td>±1.01</td>
<td>±1.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Defects</th>
<th>Horizontal probing attachment level</th>
<th>Horizontal probing bone level</th>
<th>Horizontal open bone level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buccal</td>
<td>±0.77</td>
<td>±0.62</td>
<td>±0.97</td>
</tr>
<tr>
<td>Lingual</td>
<td>±0.62</td>
<td>±0.66</td>
<td>±0.84</td>
</tr>
</tbody>
</table>
Table 3. Differences (means ± S.D. and ranges) within vertical and horizontal measurements for 1st and 2nd examiners (buccal and lingual defects combined)

<table>
<thead>
<tr>
<th></th>
<th>Vertical open bone level minus vertical probing bone level</th>
<th>Vertical probing bone level minus vertical probing attachment level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vertical open bone level minus vertical probing bone level</td>
<td>Vertical probing bone level minus vertical probing attachment level</td>
</tr>
<tr>
<td>1st examiner</td>
<td>0.9 ± 1.1 (+4 to 0)</td>
<td>1.1 ± 1.0 (+4 to -1)</td>
</tr>
<tr>
<td>2nd examiner</td>
<td>1.0 ± 1.4 (+4 to -1)</td>
<td>1.5 ± 1.2 (+5 to -1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Horizontal open bone level minus horizontal probing bone level</th>
<th>Horizontal probing bone level minus horizontal probing attachment level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st examiner</td>
<td>1.1 ± 0.9 (+3 to 0)</td>
<td>1.1 ± 1.2 (+4 to -1)</td>
</tr>
<tr>
<td>2nd examiner</td>
<td>1.1 ± 1.4 (+4 to -2)</td>
<td>1.1 ± 1.3 (+6 to -1)</td>
</tr>
</tbody>
</table>
REFERENCES


