Periodontal Probing: Probe Tip Diameter*

Jerry J. Garnick and Lee Silverstein

**Background:** Periodontal probing is one of the most common methods used in diagnosing periodontal disease. The purpose of this study was to determine the importance of the diameter of periodontal probing tips in diagnosing and evaluating periodontal disease.

**Methods:** The literature discussing periodontal probe diameters in human, dog, and monkey studies was reviewed and compared. Tip diameters varied from 0.4 to over 1.0 mm in these studies. Probe advancement between the gingiva and the tooth is determined by the pressure exerted on the gingival tissues and resistance from the healthy or inflamed tissue. The pressure is directly proportional to the force on the probe and inversely proportional to the probe tip diameter. The larger probing diameters reduced probe advancement into inflamed connective tissue. This effect of change in probe diameter reduced the pressure in a greater manner than an increase of similar change in probe force.

**Results:** In the studies reviewed, the pressure used to place the probe tip at the base of the periodontal sulcus/pocket was approximately 50 N/cm² and at the base of the junctional epithelium, 200 N/cm². A tip diameter of 0.6 mm was needed to reach the base of the pocket. Clinical inflammation did not necessarily reflect the severity of histological inflammation, and the recordings may not illustrate probing depth. Furthermore, probing depth did not identify anatomical locations at the base of the pocket.

**Conclusions:** Probe tips need to have a diameter of 0.6 mm and a 0.20 gram force (50 N/cm²) to obtain a pressure which demonstrates approximate probing depth. This pressure was needed to measure the reduction of clinical probing depth, which included formation of a long junctional epithelium as a result of therapy. In addition, different forces or diameter tips are needed to measure healthy or inflamed histological periodontal probing depths. J Periodontol 2000;71:96-103.

**KEY WORDS**

Periodontal probes; dental instruments; periodontal diseases/diagnosis.

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periodontal probe, both the force and the probe diameter (or pressure in N/cm²) are examined in order to reach valid judgments and comparisons. With tissue inflammation, resistance to the probe is reduced so that the probe with the same pressure will penetrate deeper into the tissue until a similar opposing tissue pressure is reached. If the clinician uses a probe tip with a reduced diameter, the pressure will increase and the probe tip will penetrate much deeper into the same inflamed tissue.

Because of the great effect on probing displacement, variations in probe diameter are important. The purpose of this report is to review the literature on probe diameters and discuss their importance in the use of periodontal probing.

**EARLY PERIODONTAL PROBE DESIGNS**

Observations of clinical inflammation of the gingiva and bone loss in radiographs have been used for many years for the diagnosis and treatment of periodontal diseases. In 1915, Black stated that flat periodontal probes, 15 mm long with markings every mm, should be used in examination of clinical pockets present in periodontal disease and before surgery. He recommended that the level of the pocket fluid on the probe tip be read to determine the clinical pocket depth. Probes were used at baseline examinations and before surgery. He did not recommend a probe tip diameter or probing force.

The probes most commonly used today were developed by Ramfjord in 1959. He stated that the probes in use at that time were too thick to probe narrow clinical pockets and designed a round probe with a tip diameter of 0.4 mm. This diameter of the periodontal probe was accepted as the standard.

Before Ramfjord’s publication, investigators were divided regarding the value of periodontal probes in the examination, diagnosis, and prognosis of periodontal diseases. Between 1915 and 1958, several reports supported use of the periodontal probe to determine the disease status of gingival tissues. Probe specifications, including the tip diameter, were generally not indicated, nor was there any research on the effect of probe design in most of these reports. Others did not support the use of periodontal probing, but rather supported radiographs in the diagnosis of the periodontal diseases.

Simonton proposed flat probes 1 mm wide, 10 mm long, and notched every 2 mm. Box used special gold or silver probes that had 5 different angulations. Miller suggested probing of all pockets and recording their depth and putting this information on the diagnostic chart. He used a medium-thickness silver abscess probe or a scaler, with a blunt blade.

In the late 1950s, Goldman et al., Orban et al., and Glickman published their texts on periodontal diseases. All authors agreed on the importance of the periodontal probe in diagnosis, prognosis, and treatment and supported use of the Williams probe which was rod-shaped with 1, 2, 3, 5, 7, 8, and 9 mm markings, and a 1.0 mm diameter at the tip. Goldman et al. stated that “Clinical probing with suitable periodontal instruments such as the Williams calibrated probe is a prime necessity in delineating the depth, topography and character of the periodontal pocket.” Glickman stated that “The pocket probe is an instrument with a tapered rod-like blade which has a blunt and rounded tip.” These two classic publications emphasized the use of the probe and not its configuration; furthermore, the diameter or force was not considered important. Probing was considered to measure the depth of the “histological pocket.”

During this period, the rationale for using a periodontal probe became accepted as part of the examination for periodontal diseases. In addition, the parameters for the periodontal probe as presented by Ramfjord in 1959 became accepted as the norm. However, there was little research supporting these parameters. Tibbetts indicated that determination of PD in exact millimeter measurements was important. Among the probes he reviewed were the Merritt, Williams, Michigan, and Gilmore (round) and Goldman-Fox, Drellich, and Nabers (rectangular). Neither the Merritt or Gilmore probes are calibrated. The University of Michigan probe had 3, 6, and 8 mm calibrations; the Drellich probe had 4, 6, 8, and 10 mm markings; and the Williams, Goldman-Fox, and Nabor probes were marked in 1 mm increments with 4 mm and 6 mm deleted to facilitate reading. Again, the diameters of the round tip probes were not emphasized. In 1967, Glavind and Løe reported the results of a research protocol in which they used a periodontal probe tip that was 0.8 mm in diameter with a 10 gram force.

**Measure of Clinical Pockets by Probing**

The general interpretation of periodontal probing is that the probe measured the pocket depth, which was similar to the histological depth. Therefore, by documenting the amount of displacement of the probe into the tissues, changes in probing depth could be measured. Ramfjord suggested the use of a modified Williams probe, with a diameter of 0.4 mm, which
could measure narrow pockets, rather than the original 1.0 mm. The effects of this cross-sectional modification on probe penetration were not studied.

However, published reports demonstrated the difficulty of measuring the histological pocket depth. In 1960, Kohler and Ramfjord reported that the sharp end of a No. 2 silver point (0.2 mm diameter) was utilized to measure tissue changes, and probed deeper in areas of anesthesia. The sharp pointed probe was not recommended for measuring PD, and it was recommended that PD should be measured before anesthesia was induced. At this same time, 3 reports demonstrated that 0.1 to 0.5 mm thick steel blades or cellulose acetate strips penetrated beyond the base of the sulcus and into the junctional epithelium. Zander placed a cellulose acetate film 0.1 mm thick into the sulcus of a young dog, with a very slight amount of force. The photomicrographs demonstrated the location of the strip outside and within the junctional epithelium. The strip was still wider than the junctional epithelium; therefore, resistance was by collagen fibers. The strip ended just coronal to the base of the junctional epithelium. In one part of their dog study, Orban et al. used a steel blade, 0.5 mm thick and 1 mm wide. With a light force they could probe 1 mm deep; with an increased force they could probe 1.5 mm. The probe was slightly apical to the sulcus but still adjacent to the junctional epithelium. Again, this blade was wider than the junctional epithelium. The result, however, also indicated that probing for histological pocket depth was difficult and that using thin probes results in excessive probing.

Probing depth measured both the histological sulcus/pocket and the junctional epithelium. The junctional epithelium was 15 to 30 layers thick; each cell is approximately 6 μm or 0.006 mm wide, which computes to a thickness of 0.09 to 0.18 mm. This width is too narrow even for the thin Michigan periodontal probe (0.4 mm) to penetrate without involving the adjacent connective tissue. In general, these studies indicated that probing performed with thin probes (0.1 to 0.5 mm) over-probed the sulcus and extended to the base of the junctional epithelium, and that the connective tissue adjacent to the sulcus wall was a major factor in probe resistance. Therefore, the probing instrument did not measure morphologic identifying locations, such as the base of the histological pocket and junctional epithelium, but measured general tissue resistance to the pressure placed on the probing instrument. Thus the factors involved in pressure become important in the understanding of probing.

These results were supported by studies in dogs and humans using periodontal probes. Sivertson and Burgett found that the thin Marquis (Hiatt) probe tip (0.4 mm diameter) extended to the coronal most attachment and through the junctional epithelium. Other studies reported similar results. It must be realized that even though forces used were low, pressures exerted by the probe were very high because thin probes were used; and penetration of tissues was deep.

**RELATIONSHIP OF PROBE PRESSURE, FORCE, DIAMETER, GINGIVAL MORPHOLOGY, AND INFLAMMATION TO PROBE DISPLACEMENT**

Listgarten summarized the published results by stating that “probing depth measured from the gingival margin seldom corresponded to histological sulcus or pocket depth. The discrepancy was less in the absence of inflammatory changes and increased with increasing degrees of inflammation. Following treatment, decreased probing depth measurements may be due in part to decreased penetrability of the gingival tissues.” The location of the probe tip depends on the pressure applied and resistance of the tissue. The probe has greater penetration of tissues with increasing pressure on the probe, and the resistance varied depending on tissue characteristics, morphology, and/or tissue inflammation. In general, the use of the periodontal probe resulted in over-probing of the histological pocket or sulcus.

van der Velden and Jansen described the different parameters associated with probe movement. They indicated that the pressure applied to the probe moved the probe along the tooth until an opposing pressure prevents further movement. The pressure was equal to force/area at the end of the probe tip and is stated in terms of N/cm². If the diameter of the probe tip is standardized, such as 0.6 mm, the change in pressure will be directly proportional to the change in force applied on the probe. The displacement of the probe will then depend on the force on the probe and the tissue resistance. Typical force-displacement curves can then be generated (Fig. 1). Inflammation reduces the ability of the tissues to exert pressure opposing that exerted by the probe, resulting in greater tissue penetration (Fig. 2). van der Velden and Jansen further suggested that with a probe 0.63 mm in diameter, the optimal force to probe the most coronal connective tissue attachment was 0.75 N; i.e., about 240 N/cm². Polson et
al.\textsuperscript{32} demonstrated in humans that the periodontal probe penetrated to the base of the junctional epithelium in periodontal health using 205 N/cm\textsuperscript{2}. Both pressures would reach the connective tissue attachment and not measure the formation of long junctional epithelium. Garnick et al.\textsuperscript{31} estimated that pressure of 47 N/cm\textsuperscript{2} (force of 0.2 N, diameter 0.6 mm) applied to the probe placed the tip slightly apical to the coronal edge of the junctional epithelium in healthy tissues (Fig. 3).

Tissue pressure that resists probe displacement depends on tissue morphology including loss of attachment and the severity of tissue inflammation. Clinical inflammation does not necessarily correspond to tissue inflammation (Fig. 4); i.e., obvious clinical gingival inflammation may not be as severe as with histological inflammation. Since histological inflammation affects tissue resistance, the clinician may not recognize the level of tissue resistance to the probe.

Systemic and random errors occur in periodontal probing (see reference 28 for review); this paper addresses random error. There are 4 different variables concerned with probing, 3 of which (force, tip diameter, and probe location) can be standardized, but it is difficult to standardize the fourth, connective tissue inflammation, since it is usually evaluated clinically. Standardized probing force, tip diameter, and probe location can improve calibration. In practice, probe location is not standardized because of the need to locate the most severe areas of disease for treatment. However, in research protocols, location is standardized in order to evaluate change of disease at one site.
**Figure 3.** Regression analysis of data from force-displacement curves of probing the gingival sulcus of dogs. The probe tip was estimated to be at the base of the sulcus with pressures of 47 N/cm² (474 kPa) in (A) and at the most coronal connective tissue attachment with a pressure of 298 N/cm² (1927 kPa) in (B). This demonstrated that different pressures resulted in different degrees of tissue penetration (after Cornick JJ et al.; reference 31).

**Figure 4.** Graphs demonstrating the development of clinical gingival inflammation in dogs (A) and results when the gingival tissues were evaluated histologically (B). Clinical gingival inflammation was characterized by gingival index and gingival fluid flow. Histological variations were especially great in situations of healthy and slightly inflamed (GI = 2) gingiva (after Cornick JJ et al.; reference 31).
There is a great effort to standardize force but because of the greater clinical significance, probe diameter should be standardized. There are numerous reports using various tip diameters (0.4 mm; 0.5 mm; 0.6 mm; 0.8 mm; and 1.0 mm). In a dog study, Keagle and Garnick defined the major function of the periodontal probe as an instrument to be used to discriminate changes in tissue inflammation. The probe penetrated deeper in inflamed and less with healthy tissue. Since the probe diameter is a major factor in probing, they compared force-displacement curves for probes with different diameters in healthy, inflamed and greatly inflamed tissues. Probe diameters of 0.6 mm discriminated best the different levels of gingival inflammation and health; probing deeper with increased inflammation.

The World Health Organization proposed a probing tip with a hemispheric shape and a diameter of 0.50 mm. It was felt that the rounded surface would produce less patient discomfort. However, the effect of this spherical configuration is not known, and it may be that this shape increases the area, thus reducing the pressure.

The periodontal probe is the major instrument used in diagnosis and evaluation of treatment. Root planing or repositioned flap surgery achieve a long junctional epithelium with reduced sulcular/pocket depth and reduction of tissue inflammation. The periodontal probe should be used to measure therapeutic changes, but not the connective tissue attachment level since it is generally not modified by such treatment. If the objective of probing is comparison of therapeutic changes, then the pressure should be close to 50 N/cm². If pressures of 200 N/cm² or greater are used, the probe may penetrate to the base of the long junctional epithelium and not demonstrate the reduced sulcus/pocket depth (Fig. 5 and

### Table 1.

**Comparison of Probe Tip Diameters and Force in Periodontal Problings**

<table>
<thead>
<tr>
<th>Diameters (mm)</th>
<th>Base of Sulcus ( (P = 50 \text{ N/cm}^2) )</th>
<th>Coronal Connective Tissue attachment ( (P = 200 \text{ N/cm}^2) )</th>
</tr>
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<tbody>
<tr>
<td>0.4</td>
<td>6 gr (0.06 N) (^\dagger)</td>
<td>25 gr (0.25 N) (^\dagger)</td>
</tr>
<tr>
<td>0.6</td>
<td>14 gr (0.14 N) (^\ast)</td>
<td>57 gr (0.57 N)</td>
</tr>
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</table>

Best combinations of force and probe diameters are:

\(^\ast\) 0.6 mm diameter at 20 gram force (least force in a hand-held probe) to probe the base of the sulcus and determine formation of long junctional epithelium.

\(^\dagger\) 0.4 mm diameter at 20 to 25 gram force to probe to connective tissue attachment to determine regeneration of connective tissues but not long junctional epithelium formation.

With use of a 0.6 mm diameter probe, a 20 gram force was estimated to measure sulcus depth (and long junctional epithelium formation) and 60 gram force to measure most coronal connective tissue attachment.
Table 1. If the clinician can apply force of approximately 20 grams (0.20 N) on the periodontal probe handle (in which the nail bed would not blanch), the probe tip diameter must be increased to 0.6 to 0.7 mm to reduce the pressure to the level of 40 to 50 N/cm². At this pressure, the probe tip would be placed at the coronal end of the junctional epithelium, demonstrating the formation of long junctional epithelium.

**CONCLUSION**

In summary, periodontal probing registers resistance of the tissues to the pressure applied by the probe. This pressure is directly proportional to the application of force on the probe and indirectly to the area of the probe tip. The greater the pressure, the greater is the advancement of the probe into the tissues. However, the advancement depends on the resistance of the tissues at the site being measured. Variability in probing may result because the clinically observed inflammation may not be the same as the inflammation in the tissues penetrated by the probe. However, with treatment, if the pressure is the same but the inflammation is reduced and/or tissue attachment is increased, the resistance is increased and the displacement of the probe will be less. The difference in probing depth would measure reduction of inflammation and, therefore, effectiveness of treatment.

The pressure used to measure the coronal level of the connective tissue attachment is not the same as that used to place the probe at the base of the sulcus or the pocket, which should be much less. If the measurement of long junctional epithelium and reduced sulcular/pocket depth are the objectives of probing, then reduced pressures must be used. In this case, forces of 20 grams should be used with a probe tip diameter of 0.6 mm to obtain a pressure that would measure the new sulcus depth, but not penetrate the long junctional epithelium. The larger diameters that have been used for many years, as indicated in this report, would appear appropriate.

**REFERENCES**


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Chronic Ulcerative Stomatitis: A Case Report

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Background: Certain mucocutaneous diseases present with painful, ulcerative, or erosive oral manifestations. Chronic ulcerative stomatitis is a newly recognized disease of unknown origin which presents clinically with features of desquamative gingivitis. This report marks only the thirteenth case reported in the world literature. A review of previous reports and studies is presented along with a review of immunofluorescence techniques critical to proper diagnosis. These diseases are difficult to diagnose without the use of immunofluorescence techniques. A 54-year-old Caucasian woman presented with a 2- to 3-year history of stomatitis and dry mouth.

Methods: Direct immunofluorescence revealed a speckled pattern of IgG deposits in the basal one-third of the epithelium, while indirect immunofluorescence confirmed the presence of stratified epithelium-specific antinuclear antigen (SES-ANA), both pathognomonic for chronic ulcerative stomatitis.

Results: The patient was successfully treated using topical corticosteroid therapy. J Periodontol 2000;71:104-111.

KEY WORDS
Gingivitis, necrotizing ulcerative/diagnosis; gingivitis, necrotizing ulcerative/drug therapy; gingivitis, desquamative/diagnosis; gingivitis, desquamative/drug therapy; immunofluorescence techniques.

Many skin diseases may present with painful, ulcerative, or erosive oral manifestations. These diseases often share similar oral features and definitive diagnosis is sometimes difficult. Diseases such as lichen planus, cicatricial pemphigoid, and pemphigus vulgaris are mucocutaneous disorders of unknown origin in which host antibodies are directed towards the epithelium and/or its junction with the underlying connective tissue. The presence of these antigen-antibody complexes may induce the epithelial desquamation or erosion observed intraorally. Histopathological differentiation of these conditions is very important since clinical features may be similar, but histologic findings are also often inconclusive. This may be especially true in early lesions or in lesions in which the epithelium has desquamated.

In the last few years, immunohistochemistry techniques, especially direct and indirect immunofluorescence, have been used to clarify diagnosis. Direct immunofluorescence (DIF) is performed by exposing excised lesional tissue to antibodies of various immunoglobulins, complement, and tissue breakdown products. In indirect immunofluorescence (IF), normal stratified squamous epithelium such as goat or monkey esophagus tissue is exposed to labeled circulating serum antibodies obtained from the patient. A positive result is indicated if the labeled antibody binds with a tissue antigen. To date, distinct DIF features have been identified for lichen planus, pemphigoid, and the various forms of pemphigus.1-4 Although only pemphigus is associated with consistent positive IIF findings, a limited number of reports have described a lichen planus specific antigen (LPSA) which, in one study, was found in 80% of patients with lichen planus.5,6 Others have reported the “string of pearls” phenomenon using IIF which has been linked with lichenoid reactions to certain medications.7

Recently, a distinct new disease entity, chronic ulcerative stomatitis (CUS), has been described in a limited number of case reports.8-13 CUS resembles erosive lichen planus or oral discoid lupus erythematosus in its clinical and histologic manifestations. Therefore, it is best diagnosed via immunofluorescence in conjunction with routine histopathology. DIF may reveal nuclear deposits of immunoglobulin G (IgG) in a speckled pattern mainly in the basal one-