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INTER-EXAMINER REPRODUCIBILITY OF PROBING DEPTH MEASUREMENTS WITH A MANUAL PERIODONTAL PROBE-A CROSS-SECTIONAL STUDY

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ABSTRACT:

Background:

This study aimed to assess the inter-examiner reproducibility of periodontal probing depth (PD) measurements using a manual probe, focusing on the impact of examiner training and calibration.

Materials and Methods:

Fifty adults with moderate periodontitis (Stage III/Grade B) were examined. Examiners underwent 24 hours of standardization and calibration training before conducting clinical measurements. PD measurements were taken at six sites per tooth using a UNC-15 probe. The study involved two examiners who each assessed the participants on separate days in a randomized sequence. Data analysis included a paired-sample t-test was conducted to evaluate the average differences between inter-examiner measurement pairs. Statistical significance was set at p-values < 0.05. The agreement level between paired measurements was assessed within specified variation limits, measured in increments of $\pm$ 0.5 mm.

Results:

The correlation coefficient for inter-examiner measurements was $r = 0.679$. Agreement within $\pm$ 1.0 mm was 97.4%, with significant differences between anterior and posterior teeth ($p < 0.05$) and between facial and lingual surfaces ($p < 0.05$). Proximal surfaces, particularly distal ones, showed greater variability.

Conclusion:

High reproducibility was observed within a 1 mm range, deemed acceptable for clinical settings.

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However, variability suggests that for research purposes, more precise instruments or single-examiner protocols are advisable. Rigorous examiner training and calibration are crucial for reliable periodontal assessments. The study's findings emphasize the need for consistency in periodontal probing to improve clinical decision-making.
Key words: Clinical probing depth, examiner, periodontal probe, reproducibility.

INTRODUCTION:

Periodontal probing lays the groundwork for a clinical evaluation of the periodontium, assists with periodontal diagnosis, and monitors patient treatment outcomes. [1,2] Nevertheless, it is imperative to acknowledge that the precise and replicable assessment of the periodontium poses a significant clinical hurdle, thereby augmenting the probability of encountering probing measurement inaccuracies. The parameters that are typically assessed encompass probing depth, gingival levels, the presence or absence of bleeding, and clinical attachment levels.[3]

Greater precision in measuring instruments leads to increased reproducibility of measurements. Furthermore, it allows for a greater level of control over the variables that impact the process of probing. Errors in periodontal probe measurements can occur due to numerous factors, such as differences in clinical examiner experience, varying probing forces, the extent of gingival tissue inflammation, the complex anatomy of tooth roots, and differences in probing depths. Additional factors include the specific periodontal sites being assessed, the angles at which the probe is inserted subgingival area, variations in probe tip diameter, inconsistencies in interpreting the probe's millimetre markings, the tendency to round off measurements, the patient's level of cooperation, the presence of subgingival calculus, and potential transcription errors. Collectively, these factors contribute to the overall variability and potential inaccuracies in periodontal probe measurements. [4,5]

Measurements can exhibit substantial discrepancies when different clinicians perform examinations at different times. Therefore, it is crucial to attain a high degree of consistency in clinical measurements. Over the past ten years, several pressure-sensitive automated probes have been created with the aim of enhancing reproducibility. While some researchers have noted enhanced reproducibility in their probing measurements, [6,7] others have discovered no discernible improvement when compared to traditional probes. [8-11]

To enhance the consistency of periodontal probing, it is advisable to undergo formal standardization and calibration training,[12] also referred to as examiner alignment and assessment training. [13,14] This training helps identify and reduce potential sources of variation among clinical examiners in probing assessments.

The aim of this study was to compare inter examiner reproducibility using a manual probe to obtain a clinical record of probing depth, with different variables considered.

MATERIALS AND METHODS

Ethical Approval:

The institutional Ethics Committee approved the study. Written informed consent was obtained from all patients before data collection.

Trial design, settings, and data collection location:

The trial was a double-blinded, equal allocation rate, randomized. The study was carried out in the

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department of periodontology from January 2023 to September 2023.

Pre-Study Examiner Standardization and Calibration Training:

Before commencing the investigation into reproducibility, examiners underwent personalized training and standardization for periodontal probing. This comprehensive training encompassed approximately 24 hours of lectures, hands-on bench-top exercises, clinical guidance, and assessments. [12,15]

The initial half-day session involved an instructive review of periodontal data collection principles and procedures. This session emphasized the importance of maintaining consistent manual probing forces, recognizing interproximal tooth contact points, ensuring proper alignment of the periodontal probe, adhering to rounding-up or down rules, accurately identifying reference points, locating the CEJ (Cementoenamel Junction) and GM (Gingival Margin), and performing PD (Probing Depth) measurements.

Subsequently, participants completed bench-top probing exercises using dentiform models that depicted various types of periodontitis lesions. These exercises were conducted under the supervision of two experienced periodontists recognized as "gold standard" practitioners, known for their high level of agreement in inter-examiner reliability with each other.

Two assessors underwent training through a calibration procedure. Within a calibration cohort separate from the experimental group, the study subjects were examined by each assessor once weekly for a duration of 2 months using a 15-UNC probe from Hu-Friedy Co. based in Chicago, USA. The probing routine was iterated until each assessor achieved a significant level of correlation, quantified by Cohen's Kappa ($k \geq 0.6$). In addition to achieving Kappa agreement, the measurements were required to demonstrate a 90% consensus within a range of ± 1 mm, and an exact concurrence in 75% of the repeated PD measurements.

Patients:

Following the completion of the pre-study standardization and calibration training program, two examiners carried out reproducibility examinations on a group of 50 adults who were in good systemic health. Among these participants, there were 23 males and 27 females, ranging in age from 35 to 65 years, with an average age of 47.8 ± 8.1 years (standard deviation).

These adults presented with varying degrees of severe periodontitis, equivalent to Stage III/Grade B periodontitis according to classification.[2] To be included in the study, participants needed to have at least two quadrants in their dentition with at least four periodontal sites displaying a probing depth (PD) of ≥ 5 mm along with bleeding on probing (BOP). Among these sites, at least two had to exhibit a PD of ≥ 7 mm. Each participant had to have a minimum of six teeth per quadrant to be included in the study.The study's exclusion criteria for participants encompassed several factors: the existence of fixed or partial prosthetic devices, individual crowns, or orthodontic interventions. Additionally, individuals who had undergone surgical or non-surgical periodontal treatments within the past 8 months, as well as pregnant individuals, were not eligible for inclusion.

Probe:

In this study, the periodontal probe used a standard UNC-15 probe (UNC #15, Hu-Friedy, Chicago, Illinois, USA). All the measurements were rounded off to 0.5 mm.

Clinical measurements:

In each study participant, clinical measurements were conducted at six specific locations on each tooth.

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Probing depth (PD) was determined by measuring the distance, rounded to the nearest whole millimetre, from the gingival margin to the deepest point where the probe tip entered the gingival tissue. This measurement was performed using a UNC-15 periodontal probe, and the probe was positioned parallel to the long axis of the tooth for accuracy. For interproximal PD measurements, the examination was carried out immediately adjacent to interproximal tooth contact points. If no interproximal contact was present between the teeth being assessed, those particular periodontal sites were excluded from the analysis.

Examination procedure:

A proficient and calibrated examiner performed the clinical assessments. To ensure a dry environment during the clinical examinations, cotton roll isolation and air-drying techniques were employed. The measurement values were verbally communicated to a data recording assistant for transcription. All clinical measurements were taken at six sites per tooth (mesiobuccal, buccal, distalbuccal, mesiolingual, lingual, and distolingual). Each participant had to have a minimum of six teeth per quadrant to be included in the study. Using a UNC-15 probe, two examiners conducted probing depth (PD) measurements and determined all quadrants of the participants' dentition. The PD measurements were taken as follows: On day 1, examiner 1 conducted the PD; two days later (day 3), examiner 2 performed the PD. This same procedure was applied to all 50 participants until complete data had been collected for each of them. Every individual underwent probing a maximum of two times. In summary, all 50 participants were examined once during separate appointments by the two examiners, and the sequence of the examiners was randomized.

DATA ANALYSIS:

A paired-samples t-test was conducted to evaluate the mean differences between sets of measurements for inter-examiner comparisons. A p-value of less than 0.05 was considered statistically significant. The level of agreement between the measurement pairs was assessed within specified variation limits, with increments of ± 0.5 mm.

RESULTS:

The correlation coefficients for duplicate measurements taken by examiners A and B (inter-examiner) were r = 0.679. [Table 1] shows the levels of agreement between duplicate measurements for inter-examiner A-B. The agreement of inter-examiner probing depth measurements at variations of ± 0.0, ± 0.5, and ± 1.0 millimetres were 49.3%, 85.1%, and 97.4%, respectively. The differences between measurements taken by examiner A and examiner B (inter-examiner differences) were statistically significant (p=0.001).

This trend was consistently observed for both types of teeth (anteriors and posteriors) as well as for six specified tooth surfaces. [Table 2] presents the agreement comparison between anterior and posterior teeth, while [Table 3] provides a comparison among the six specified tooth surfaces.

The agreement for duplicate probing depth measurements was significantly higher for anterior teeth compared to posterior teeth ($p<0.05$). Variability was notably greater in proximal surfaces, especially distal surfaces, compared to mid-facial or mid-lingual surfaces [Table 4] ($p<0.05$). The difference in agreement between mesial and distal surfaces was not significant [Table 5] (p=0.434). Additionally, facial surfaces showed significantly more agreement than lingual surfaces ($p<0.05$).

Table 1. Agreement of probing depth measurements for inter-examiner A-B (%)

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Variation	A-B
±0.0	49.3
±0.5	85.1
±1.0	97.4
±1.5	99.4
±2.0	100.0

Table 2. Agreement of probing depth measurements inter-examiner A-B in anterior and posterior teeth (%)

Variation	A-B Anterior	A-B posterior
±0.0	49.1	47.3
±0.5	86.2	84.9
±1.0	99.6	96.8
±1.5	100.0	99.1
±2.0	100.0	100.0

Table 3. Agreement of probing depth measurements for inter-examiner A-B at 6 specified tooth surfaces (mesiofacial, midfacial, distofacial, mesiolingual, midlingual, distolingual) (%)

Variation	A-B Mesiofacial	A-B Midfacial	A-B Distofacial	A-B Mesiolingual	A-B Midlingual	A-B Distolingual
±0.0	42.8	63.7	41.3	40.6	59.4	41.2
±0.5	86.8	95.2	75.9	81.1	91.5	77.2
±1.0	99.2	97.9	96.2	98.5	99.6	98.1
±1.5	99.7	99.7	100.0	100.0	100.0	99.1
±2.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 4. Agreement of probing depth measurements for inter-examiner A-B for facial and lingual surfaces (%)

Variation	A-B Facial	A-B Lingual
±0.0	50.4	46.7
±0.5	86.2	83.2
±1.0	98.7	97.8
±1.5	99.8	99.5
±2.0	100.0	100.0

Table 5. Agreement of probing depth measurements for inter-examiner A-B for mesial, mid and distal surfaces (%)

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Variation	A-B Mesial	A-B Mid	A-B Distal
±0.0	42.8	61.8	41.1
±0.5	84.2	93.2	75.9
±1.0	98.7	99.1	98.1
±1.5	99.9	99.8	99.7
±2.0	100.0	100.0	100.0

DISCUSSION:

This study assessed the inter-examiner reproducibility between two trained and calibrated examiners using a manual probe for the clinical recording of periodontal probing depth (PD). The extensive number of probing sites recorded by the examiner (n = 6,782) and thorough operator calibration were shown to be essential for ensuring reliable records that can support sound decision-making. A possible reason could be the distinct differences among examiners, such as variations in probing techniques, applied force, and other factors. [16,17]

The agreement of duplicate measurements using a manual probe was notably high within a 1 mm range (exceeding 98%), which is considered an acceptable tolerance for examiner agreement.[11] This is important to note, as it indicates that in clinical settings, a 1-mm discrepancy between examiners might be acceptable for decision-making over time. However, for research purposes, particularly in longitudinal studies where even 0.10 mm changes can be statistically significant, it is advisable to use a single examiner with more precise instruments to reduce probing errors. [10,11]

The correlation coefficients and agreements for inter-examiner duplicate measurements in this study were consistent with those reported in most previous studies. [9,18,19] However, the results were slightly higher than those in some previous studies, likely due to the examiners being highly educated and well-trained. In this study, anterior sites demonstrated better reproducibility than posterior sites, aligning with earlier reports. [8,9,19,20] Similarly, facial surfaces exhibited slightly higher reproducibility than lingual surfaces, while variability in proximal surfaces, particularly distal surfaces, was greater than in mid-facial or mid-lingual surfaces. These findings are consistent with those of previous studies. [9,20] The higher reproducibility observed at anterior, facial, and mid-facial/mid-lingual sites was anticipated due to their better accessibility and easier probe alignment. Another contributing factor is the "searching phenomenon" described by Freed.[17] Many examiners tend to believe that posterior and proximal sites have deeper probing depths, leading them to apply more force unconsciously when probing these areas. This can result in increased variability and error.

There is a concern that repeated probing of the same site might cause changes in the sulcus, affecting the measurements. Research has shown that probing causes an immediate but temporary shock to the gingival tissues. If a site is re-probed immediately, the second measurement might be influenced by the first. However, if there is a 5-minute interval before re-probing, the second measurement remains unaffected by the first.[21] In our study, no sites were re-probed immediately.

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CONCLUSION:

This study demonstrated that inter-examiner reproducibility for periodontal probing depth (PD) measurements using a manual probe is high within a clinically acceptable 1 mm range, particularly in anterior and facial surfaces. However, greater variability was observed in posterior and proximal sites, which highlights the need for careful attention in these areas. The rigorous standardization and calibration training undertaken by examiners contributed significantly to the consistency of measurements, underlining the importance of such training in clinical practice to reduce variability. While a 1 mm tolerance may be adequate for clinical decision-making, more precise instruments or the use of a single examiner may be necessary for research purposes, particularly in studies requiring high accuracy. The findings emphasize the importance of examiner training and the potential limitations of manual probing in certain anatomical sites. Despite these challenges, the study supports the use of manual probing as a reliable method for clinical periodontal assessment when proper training and calibration are implemented.

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Nil.

CONFLICTS OF INTEREST:

There are no conflicts of interest.

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