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Comparative evaluation of the accuracy and reproducibility of the probing depth measurements using unc-15 and a pressure sensitive periodontal probe: An Invitro-study

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Abstract

Aim: The purpose of the present in vitro study was to measure the accuracy and reproducibility between a conventional and a pressure sensitive periodontal probe.

Materials and Method: The study included 16 examiners who were trained in using the periodontal probes. Two aluminum boxes with 15 predrilled holes of varying depths in each, simulating a periodontal pocket with a silicone base were examined by participants. This methodology improved the likelihood that any probing errors identified were generated by the probes themselves. Two probes, University of North Carolina probe i.e. UNC-15 and a pressure sensitive periodontal probe, were randomly distributed to the participants. Participants measured 30 holes in two aluminum boxes, on an average interval of one week. The mean measured depth for each hole was calculated and compared to the true depth for each participant. Intra and inter-examiner accuracy and reproducibility for each of the duplicate measurements were recorded. Data was analyzed by paired-sample t-test. A p-value <0.05 indicated statistical significance.

Results: When used by participants, the UNC-15 probe was reproducible but not necessarily accurate; and pressure sensitive periodontal probe was both accurate and reproducible.

Conclusion: Depth measurements with the pressure sensitive periodontal probe were more accurate and reproducible when compared to UNC-15 probe.

Keywords: UNC-15, Pressure Sensitive Probe, Accuracy, Reproducibilty, Inter-examiner, Intra-examiner, Error

Introduction

The periodontium is a type of an attachment apparatus, which involves tissues that support the teeth. It consists of gingiva, cementum, periodontal ligament and alveolar

bone [1]. Clinical attachment loss (CAL), pocket probing depth and gingival recession are the main indicators of pathogenesis of periodontal destruction. CAL can be measured using periodontal probes [2-3].

Periodontal probes are one of the specific and accurate diagnostic tools to measure the pocket depth [4]. However, probing measurements can be affected by numerous factors related to the probe, examiner and environment. The markings on the probe along with the probe diameter can affect the measurements. The most important examiner-related factor is the force applied while probing and the angle of the probe. Other factors related may include experience and pattern of probing with a fixed reference point. Anatomy of the roots and inflamed soft tissue around the pocket, also affects the probing measurements. By reducing the measurement errors, we can increase the accuracy of the readings [5-12].

Therefore, it is evident that there may be no universal consensus on an ideal probe type for measurement purposes. Hence, there is an urgent need for a superior measurement device. The present study aimed to measure the accuracy and reproducibility of UNC-15 (first generation probe) and Pressure Sensitive Probe (second generation probe). The objectives of the study was to eliminate the inter and intra-examiner error.

UNC 15 Probe

The University of North Carolina probe (PCP UNC 15, Hu Friedy Manufacturing Co., Chicago, IL, USA), is one of the widely used conventional probe in large clinical trials [13]. The probing force is not constant. It may vary from 15 gm to, as much as 400 gm due to lack of pressure indicator system and rigidity of the instrument [14].

Pressure sensitive probe

Pressure sensitive probe are the second generation probes. They come with a pressure indicator system which induces constant force that do not differ irrespective of the examiner and time. The force may range from 30 gm to 50 gm.

Materials and methods

Two aluminium boxes were customized for the study purpose. Each box had 15 pre-drilled holes simulating pocket depths. The measurement of the depths ranged from 2 mm to 11 mm which were randomly allocated. These depths are referred as the actual depths. The floor of the holes was flat and made using silicon material, simulating he base of a pocket [Figure 1].

Figure 1

The study included 16 participants from the department of Periodontics, Bharati Vidyapeeth (Deemed to be) University, Dental College and Hospital, Navi Mumbai, India. Participants included 4 teaching faculty, 4 post graduate students, 4 interns and 4 under graduate students. The participants were introduced to the selected probes along with the calibration system of each probe. They were well trained before the study to reduce examiner related probing errors. Two probes used in this study were: UNC-15 (First generation probe) [Figure 2a] and Pressure sensitive probe (Second generation probe) [Figure 2b].

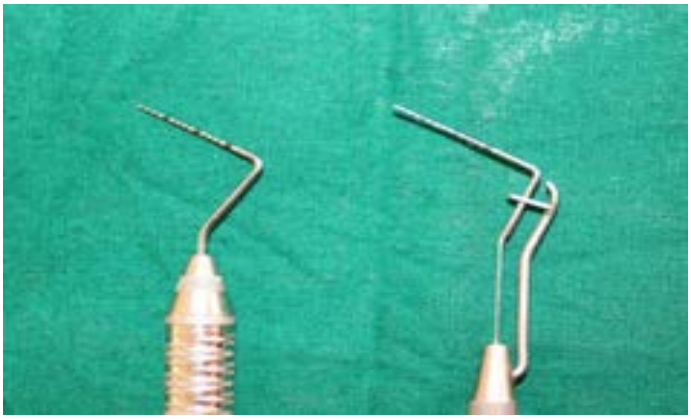


Figure 2a & 2b.

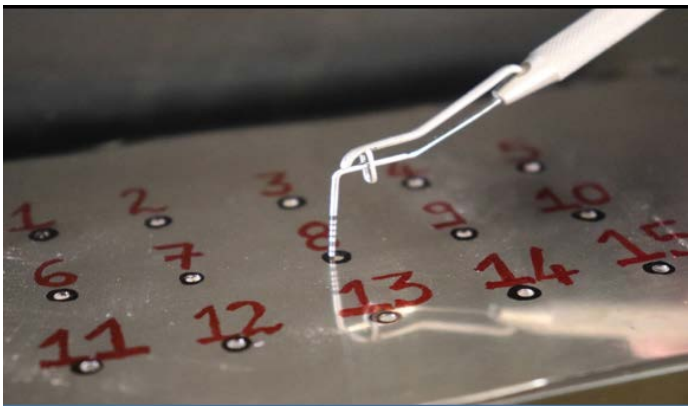


Figure 3

The UNC-15 is a conventional first-generation probe, whereas the other is a pressure indicator probe. The UNC-15 had grooved markings from 1-15 mm [Fig. 2a]. The Pressure sensitive probe presented with markings 1-15mm along with a pressure indicator for consistent force application [Fig. 2b].

The participants were not aware of the actual probing depths. Each participant was asked to measure the depths of the holes using both the selected probes which were randomly distributed to them by the examiner. Participants were asked to repeat the same procedure after an interval of 1 week.

Statistical analysis

All data was entered into a Microsoft Office Excel (version 2016) in a spreadsheet which was prepared and validated for the data form. Data was entered and checked for errors and discrepancies.

Data analysis was done using windows based 'MedCalc Statistical Software' version 18.11.3 (MedCalc Software bvba, Ostend, Belgium; https://www.medcalc.org; 2019).

The error in probing depth was calculated as differences of the readings and the actual depth. The probing depths and the error in the measurements was expressed as mean with SE and SD. 95% confidence interval will be presented.

The errors in the probing depth was compared for differences using analysis of covariance (ANCOVA) with probing method as independent variable and error as the dependent variable. The covariate was the operator and the time (two time periods).

Paired comparison was made for each operator and each probe between the first reading and second reading. Intra-examiner variability (reliability) was analysed using the Kappa's reliability test.

Results and Discussion

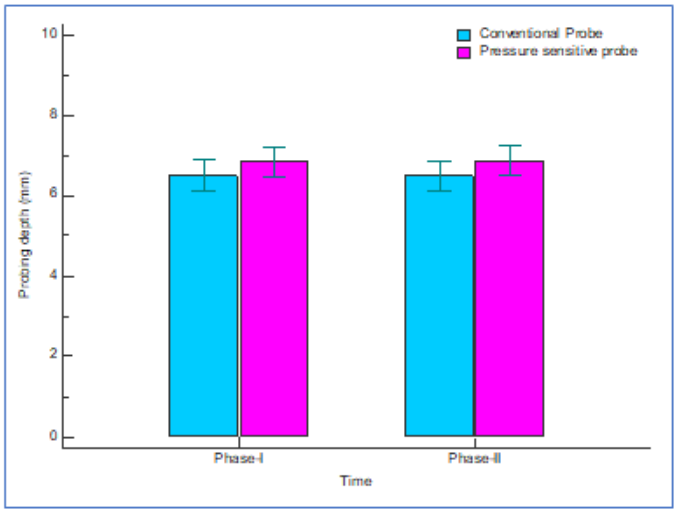
Results: ANCOVA test presented with statistically significant difference between the two readings of each probe, whereas the difference between from baseline to 1 week for each of the probe was not statistically significant (p=0.098) [Table 1]. The interactions between the examiner and the probe was significant (p=0.000), that is, some of the examiners exhibited better accuracy with UNC-15, whereas some did with pressure sensitive probe. The interaction between the examiner and the reading was significant, that is some examiners measured accurately in the first reading, whereas some did in the second. The interaction between the probe and the reading was not significant (p=0.742), that is, each probe showed similar accuracy data when the two readings were considered. The overall percentage of accuracy was higher with Pressure Sensitive probe compared with UN-15 probe.

Probing depth (PD)

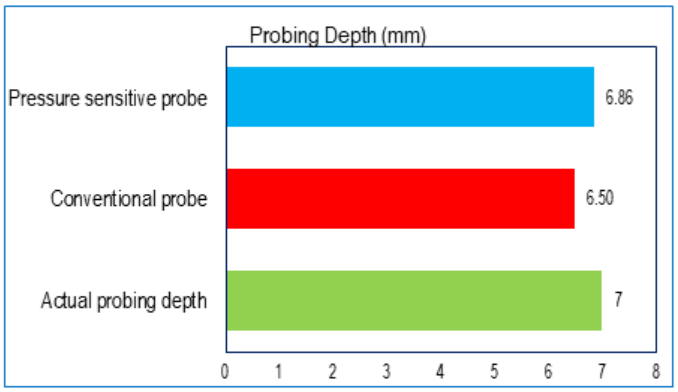
The mean probing depths were measured from baseline to 1 week for both UNC-15 and pressure sensitive periodontal probes. The differences between the mean measurements of the two probes were statistically significant (p=0.048) [Table 1].

Actual probing depth (mm)	Phase-I (Before)				Phase-II (After)			
	Conventional probe		Pressure sensitive probe		Conventional probe		Pressure sensitive probe	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
3.0 mm	2.7	0.4	2.9	0.4	2.7	0.4	2.9	0.4
4.0 mm	3.6	0.3	3.9	0.5	3.6	0.3	3.9	0.5
5.0 mm	3.9	0.4	4.6	0.5	3.9	0.4	4.6	0.5
10.5 mm	10.0	0.3	10.4	0.4	10.0	0.3	10.4	0.4
10.0 mm	9.8	0.5	9.6	1.4	9.8	0.5	9.6	1.4
3.5 mm	3.3	0.4	3.5	0.4	3.3	0.4	3.5	0.3
4.0 mm	3.5	0.7	4.0	0.3	3.4	0.5	4.0	0.2
7.0 mm	6.5	0.5	6.8	0.2	6.5	0.5	6.8	0.2
8.5 mm	7.9	0.6	8.4	0.6	7.9	0.6	8.4	0.6
11.5 mm	10.9	0.8	11.3	0.9	10.9	0.8	11.3	0.9
4.0 mm	3.7	0.4	3.9	0.4	3.7	0.4	3.8	0.4
6.0 mm	5.3	0.4	5.9	0.3	5.3	0.4	5.9	0.3
7.5 mm	7.2	0.5	7.6	0.4	7.2	0.5	7.7	0.4
9.0 mm	8.5	0.4	9.0	0.5	8.5	0.4	9.0	0.5
11.5 mm	10.8	0.5	11.3	0.6	10.8	0.5	11.3	0.6

Table 1: Descriptives for probing depth (mm)

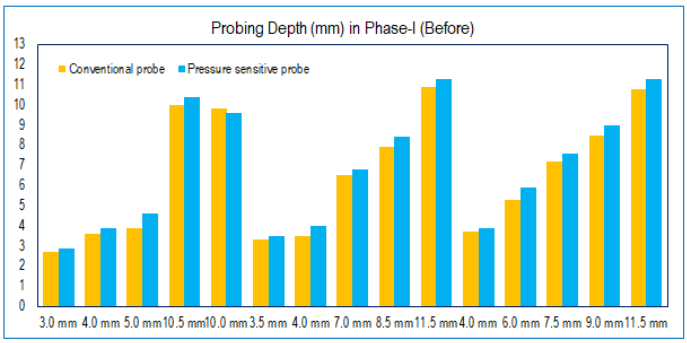


Graph 1: Mean probing depth (mm) at baseline (Phase I) and 1 week (Phase II)

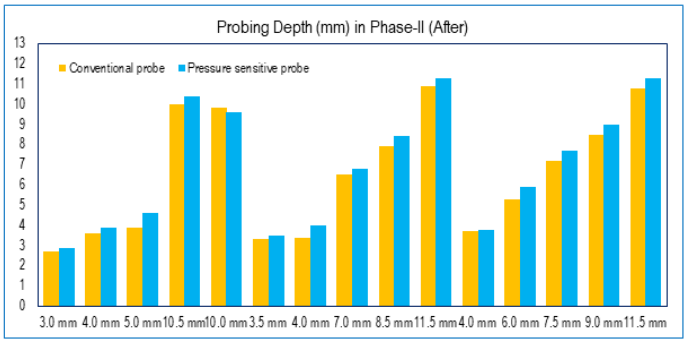


Graph 2: Mean probing depth (mm) of conventional & pressure sensitive probe in comparison with the actual probing depth

The mean difference in the probing depth measurements of each probe at baseline and 1 week was not statistically significance (p=0.073) [Graph 3 & 4].



Graph 3

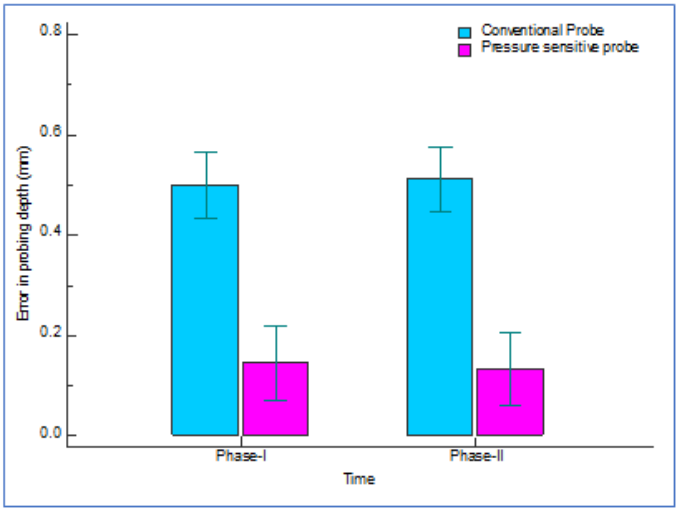


Graph 4

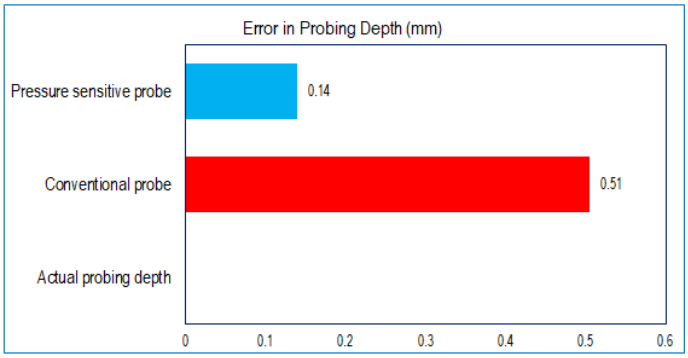
4.1.1. Error in probing depth (ΔPD)

Actual probing depth (mm)	Phase-I (Before)				Phase-II (After)			
	Conventional probe		Pressure sensitive probe		Conventional probe		Pressure sensitive probe	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
3.0 mm	0.31	0.40	0.13	0.39	0.31	0.40	0.13	0.39
4.0 mm	0.38	0.29	0.13	0.53	0.38	0.29	0.09	0.49
5.0 mm	1.13	0.39	0.44	0.48	1.13	0.39	0.44	0.48
10.5 mm	0.47	0.34	0.13	0.39	0.47	0.34	0.13	0.39
10.0 mm	0.19	0.48	0.44	1.42	0.19	0.48	0.44	1.42
3.5 mm	0.25	0.41	0.00	0.37	0.25	0.41	-0.03	0.34
4.0 mm	0.53	0.67	0.03	0.34	0.63	0.53	-0.03	0.22
7.0 mm	0.53	0.46	0.16	0.24	0.53	0.46	0.16	0.24
8.5 mm	0.56	0.63	0.13	0.56	0.56	0.63	0.13	0.56
11.5 mm	0.56	0.81	0.25	0.93	0.63	0.76	0.25	0.93
4.0 mm	0.31	0.36	0.13	0.39	0.31	0.36	0.16	0.40
6.0 mm	0.72	0.41	0.13	0.34	0.72	0.41	0.09	0.27
7.5 mm	0.34	0.47	-0.09	0.38	0.34	0.47	-0.16	0.35
9.0 mm	0.50	0.45	0.03	0.50	0.50	0.45	0.03	0.50
11.5 mm	0.72	0.55	0.19	0.57	0.72	0.55	0.19	0.57

Table 2: Descriptives for error in probing depth (mm)

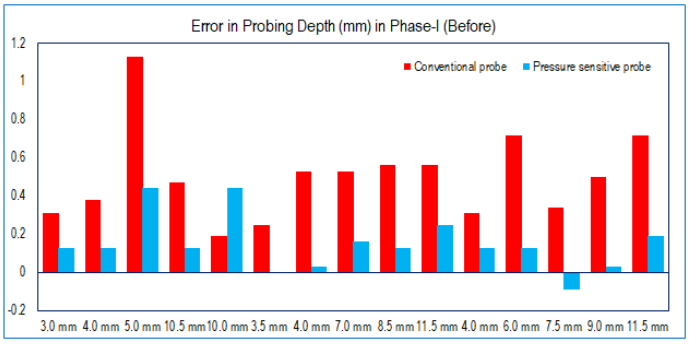


Graph 5: Mean error in probing depth (mm) at baseline (Phase I) and 1 week (Phase II)

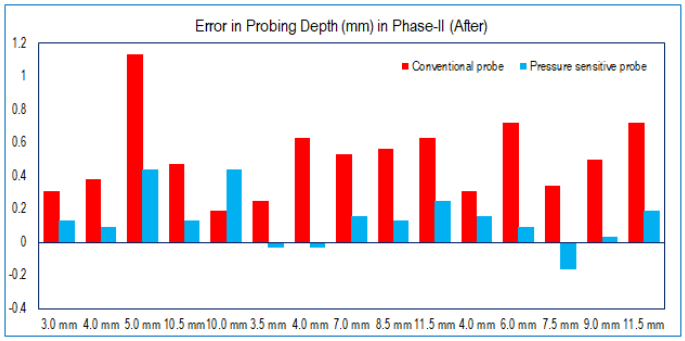


Graph 6: Errors in probing depth (mm) of conventional & pressure sensitive probe in comparison with the actual probing depth

The mean difference in the error in the probing depth measurements of each probe at baseline and 1 week was statistically significant (p=0.042) [Graph 7 & 8].



Graph 7



Graph 8

Intra-examiner variability (reliability)

There was no statistically significant difference in comparing the reliability of each probe from baseline to 1 week.

Table 3: Intra-class correlation and Reliability for probing depth measurement

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
1.000	1.000	2 (Before & After)

Table 3(a)

Inter-Item Correlation Matrix

	Before	After
Before	1.000	0.999
After	0.999	1.000

Table 3(b)

Inter-Item Covariance Matrix

	Before	After
Before	8.744	8.725
After	8.725	8.718

Table 3(c)

Intraclass Correlation Coefficient

	Intraclass Correlation[b]	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound	F Test with True Value 0 Value	df1	df2	Sig
Single Measures	0.999[a]	0.999	0.999	2675.853	479	479	<0.0001
Average Measures	1.000[c]	1.000	1.000	2675.853	479	479	<0.0001

Table 3(d)

Discussion

Currently, the ideal method of recording the periodontal status is assessment of clinical attachment level. It is important to use accurate diagnostic tools to measure CAL, for early diagnosis and preventing further progression of the disease, by fostering proper and timely treatment [2,15].

Periodontal probes are one of the prime diagnostic instruments for detection and measurement of periodontal pockets and CAL. They are also used in locating subgingival calculus and identifying the periodontal pathologies like furcation involvement, soft tissue anomalies etc. In addition, it can be used as a measurement tool to assess the size of the inta-oral lesions, width of attached gingiva and measurement of gingival recession [16].

The methodology used in the present study compared and evaluated whether UNC-15 and pressure sensitive periodontal probe gave accurate readings when compared to actual depths and reproducible when repeated after 1 week interval based on the operator experience. This was based on the studies done by Samuel et al; (1997), Buduneli et al; (2004) and Al Shayeb et al; (2014) [17-19].

This study also evaluated variability in inter and intra-examiner error between the readings taken by 16 trained and calibrated examiners as they used the selected probes. This was in accordance to the studies done by Karpinia *et al*; (2004) and Preshaw *et al*; (1997) where they evaluated the examiner related errors [20-21].

This study used similar boxes to those used by the Samuels et al; (1997), Buduneli et al; (2004) and Al Shayeb et al; (2014), in their study[17-19]. However, in this study the base of the box was made of silicone rather than plastic or metal, which simulated periodontal sulcus. This eliminates environmental factors affecting the probing measurements and also enables evaluation of the probing pressure in relation to the probing depths [22].

The accuracy was measured by comparing the readings obtained from UNC-15 and Pressure sensitive probes with the actual depth of the predrilled holes in the box. The readings obtained using pressure sensitive probe were more accurate when compared to the actual probing

depths. The results were in accordance to the study done by Samuels et al; (1997), Buduneli et al; (2004) and Al Shayeb et al; (2014) [17-19].

In our study, the reproducibility in measurements of PD values was found to be better in pressure sensitive probe than UNC-15 probe when compared from baseline to 1week. This was due to the constant force application and improved standardisation of force not exceeding 0.2 N/mm^2 when compared to UNC-15 probe. This was in agreement to the studies done by Buduneli et al; (2004), Listgarten; (1990) and Osborne et al; (1999) [6,18,23].

Probe related factors affect the reproducibility. It was thus evaluated that the errors in the readings using UNC-15 was more as compared to the pressure sensitive probe. Examiner related error must also be considered. Second generation probes are ideal to use in regular dental practices and large epidemeological studies due to their ease of providing consistency without any computerisation [13, 24].

In our study, the pocket depth measurements produced by UNC-15 were deeper compared to those produced by pressure sensitive probe, thus the result presented with statistical significant difference between the measurements using each of the probes. This was in accordance to the results obtained by Samuels et al; (1997), Buduneli et al; (2004) and Al Shayeb et al; (2014) [17-19].

Additional studies, with large sample size are needed to accurately assess the properties of each individual probe. The use of a silicone based 'periodontal model' can also be done for assessment of the probing pressure compare to the probing depths. The present methodology using the selected probe types could also be incorporated into an in vivo study comparing trained and untrained examiners.

Conclusion

The Pressure Sensitive Probe has the potential to offers a consistent, accurate mechanism to measure and monitor pocket depth over time. It was thus evaluated that pressure sensitive probe have more accuracy and reproducibility with less inter and intra-examiner errors when compared to the UNC-15 periodontal probe.

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