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Original article

Comparative evaluation of accuracy of periodontal probing depth and attachment levels using a Florida probe versus traditional probes

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ABSTRACT

Background: The current interest in the assessment of Clinical attachment level (CAL) has stimulated recent introduction of novel periodontal probes. CAL is currently the gold standard for diagnosis and monitoring of periodontal disease. The errors inherent to the use of a periodontal probe are variation in probing force, visual errors in identifying the cemento–enamel junction (CEJ), relative attachment level landmarks, fluctuations in gingival inflammation and misrecording measurements. The present study has been undertaken to compare the accuracy of measuring probing depth (PD) and CAL using Florida probe and Williams probe. **Methods:** After random selection of sixty subjects PD and CAL were measured at mandibular first molars region using Williams probe, Florida probe and CEJ probe by two different examiners. The measurements recorded by using three probes were subjected to statistical analysis for comparison of accuracy and reproducibility.

Results: Difference in mean PD with Williams probe and Florida probe were statistically significant with *p* value of .000. Similarly the CAL measurement achieved by Williams probe and CEJ probe showed significant different results. More consistent results were seen with Florida probe and CEJ probe when the measurements of PD and CAL were done by two different examiners. **Conclusion:** Florida probe and CEJ probe have been shown to be more accurate and were found to be more consistent which were reproducible by two independent examiners.

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Introduction

The methods of diagnosis of periodontal disease is evaluated by presence of inflammation, specific bacteria, gingival crevicular fluid flow and periodontal probing demonstrate lack of

sensitivity and objectivity to be totally reliable criteria for clinicians.^{1,2} Currently, PD, loss of connective tissue attachment and bleeding on probing are generally used to estimate severity of inflammation and response to treatment which needs the use of the periodontal probe.¹ One of the more reliable and convenient way of detecting, measuring and assessing the

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status of periodontal disease activity is through the use of periodontal probes. It has been a goal to find out the most suitable periodontal probe, with the most accurate recording of PD and CAL with maximum comfort for the patients.³

Williams periodontal probe was invented in 1936 by Charles H.M. Williams, which is the prototype or benchmark for all first-generation probes (Fig. 1).⁴ Common disadvantages of conventional probing are variation in probing force, visual errors in identifying the CEJ, relative attachment level landmarks, fluctuations in gingival inflammation and misrecording of measurements. Earlier pressure sensitive probes have been designed by Amitage in 1977 and Vander Velden in 1978 to standardize the insertion pressure. Subsequently, it was modified with a displacement transducer for electronic pocket-depth reading.⁵

The Florida Probe® (Florida Probe Corp, Gainesville, FL) was devised by Gibbs et al in 1988 consisting of a probe hand piece and sleeve, a displacement transducer, a foot switch, and a computer interface/personal computer. The hemispheric probe tip has a diameter of .45 mm and the sleeve has a diameter of .97 mm (Figs. 1 and 2). Constant probing pressure of 15 g is provided by coil springs inside the handpiece. The edge of the sleeve is the reference from which measurements are made and the probe has Williams' markings, however actual measurement of the pocket depth is made electronically and transferred automatically to the computer when the foot switch is pressed.⁶

The Florida probe also can record missing teeth, recession, pocket depth, bleeding, suppuration, furcation involvement, mobility and plaque assessment.⁷ Each measurement is recorded with potentially .2-mm accuracy. Comparison to previous data can be made more quickly and accurately (The system shows black arrows for changes between 1 mm and 2 mm and red arrows are used for changes >2 mm). Also, there is a chart showing diseased sites which can be used in patient education. The Florida Probe does have some disadvantages which include, underestimating deep probing depths and a lack of tactile sensitivity. Also, clinicians need to be trained to operate these probes.⁸

Aim of this study was to assess and compare the accuracy of the Florida probe and Williams periodontal probe

Fig. 1 – From top to bottom, cemento enamel junction probe, Florida probe, Williams periodontal probe.

Fig. 2 – Florida probe equipment consist of computer/laptop, USB interface, foot controls and probes (Florida probe & cemento enamel junction probe).

in determining the periodontal pocket depth and clinical attachment level. The objectives of study was to determine whether Florida probe is better in determining periodontal pocket depth when compared with Williams periodontal probe and also to determine whether CEJ probe (a component of Florida probe system) is better in determining CAL when compared with Williams periodontal probe. Objective also includes to find out the reliability of two periodontal probes when used by two different examiners.

Materials & methods

A clinical study was carried out amongst the patients attending the Central OPD of Dept of Dental Surgery, AFMC, Pune. A total of 60 subjects were selected according to the undermentioned inclusion and exclusion criteria. An informed consent was taken from all the subjects.

Inclusion criteria

Total of 60 Subjects included were in age group of 35–60 years with more than 14 teeth present in the mouth including mandibular first molars. Thirty cases were with clinical diagnosis of generalized severe chronic periodontitis with probing depth ≥ 5 mm in more than 1/3rd of total teeth present and thirty with healthy periodontium were subsequently randomly examined.

Exclusion criteria

Patients with history of bleeding disorders, on medication interfering with blood coagulation, with history of severe systemic disease eg. cardiovascular, renal, hepatic or immunologic disorder and patients requiring antibiotic prophylaxis prior to any invasive dental care were excluded in the study.

Procedure

Tooth examined in each patient were mandibular first molars 36 and 46. Probing pocket depth was recorded at six sites in each

Fig. 3 – Pocket depth being recorded in 36 (i.e. first mandibular left molar) using a custom made acrylic stent.

first mandibular molars i.e. mesiobuccal (L_1, L_7), mid buccal (L_2, L_8), distobuccal (L_3, L_9), mesiolingual (L_4, L_{10}), mid lingual (L_5, L_{11}) and distolingual (L_6, L_{12}) locations of each mandibular first molar 36 and 46 respectively. Each tooth was examined by two observers separately to eliminate inter examiner bias. Pocket depth was recorded by use of Williams periodontal probe and Florida probe in the same sites and same teeth, using custom made acrylic splint on both sides of first molars to make probing location consistent (Fig. 3). Clinical attachment levels was recorded on mandibular first molars at same six sites by two different observers by Williams periodontal probe and CEJ Florida probe using acrylic splint as a guide.

After collection of data i.e. probing depth and clinical attachment levels, subjects were divided into eight groups as follows:

First examiner

- Group A – Pocket depth by Williams periodontal probe.
- Group B – Pocket depth by Florida probe.
- Group C – CAL by Williams periodontal probe.
- Group D – CAL by CEJ Probe (Florida probing system).

Second examiner

- Group A_1 – Pocket depth by Williams periodontal probe.
- Group B_1 – Pocket depth by Florida probe.
- Group C_1 – CAL by Williams periodontal probe.
- Group D_1 – CAL by CEJ probe.

Comparison of data between Group A & B, Group A_1 & B_1 , Group C & D, Group C_1 & D_1 was performed by using tabulation and statistical analysis. Statistical analysis was done comparing the results of Probing depth using Williams periodontal probe & Florida probe and CAL by using Williams periodontal probe & CEJ probe (component of Florida probe system) by both examiners.

The tests used for statistical analysis included t-test to find out statistical difference between Williams probe and Florida probe for measuring pocket depth, Williams probe and CEJ probe (component of Florida probe system) for measuring CAL. Paired t test was performed to find out the statistical difference between examiner 1 and 2. Inter examiner reliability was calculated using correlation and alpha values.

Results

Total number of 60 subjects participated in the study. Probing depth and clinical attachment levels were taken as parameters

Fig. 4 – Mean probing depth in mm in Group A, Group B, Group A_1 & Group B_1 at locations 1 to 12.

Table 1 – Comparison of PD measured by Williams probe and Florida probe by examiner 1 & examiner 2.

Paired t-test PD-examiner 1 & examiner 2							
Examiner 1		Mean	Std. deviation	Examiner 2		Mean	Std. deviation
Pair 1	L1 A	4.93	2.612	Pair 1	L1 A1	4.63	1.974
	L1 B	3.80	2.140		L1 B1	3.80	2.140
Pair 2	L2 A	3.07	2.212	Pair 2	L2 A1	3.63	1.829
	L2 B	2.40	1.886		L2 B1	2.40	1.886
Pair 3	L3 A	3.80	1.750	Pair 3	L3 A1	4.33	1.647
	L3 B	2.80	1.710		L3 B1	2.80	1.710
Pair 4	L4 A	3.07	1.461	Pair 4	L4 A1	3.57	1.633
	L4 B	2.60	1.329		L4 B1	2.60	1.329
Pair 5	L5 A	2.77	1.406	Pair 5	L5 A1	3.00	1.174
	L5 B	1.93	1.311		L5 B1	1.93	1.311
Pair 6	L6 A	3.00	1.819	Pair 6	L6 A1	3.17	1.367
	L6 B	2.43	1.547		L6 B1	2.43	1.547
Pair 7	L7 A	3.17	1.599	Pair 7	L7 A1	3.30	1.442
	L7 B	2.47	1.224		L7 B1	2.47	1.224
Pair 8	L8 A	2.33	1.446	Pair 8	L8 A1	2.47	1.167
	L8 B	1.50	1.042		L8 B1	1.50	1.042
Pair 9	L9 A	3.10	1.447	Pair 9	L9 A1	3.20	1.324
	L9 B	2.23	.971		L9 B1	2.23	.971
Pair 10	L10 A	2.60	1.037	Pair 10	L10 A1	2.60	1.037
	L10 B	2.00	.643		L10 B1	2.00	.643
Pair 11	L11 A	2.43	.817	Pair 11	L11 A1	2.43	.817
	L11 B	1.53	.629		L11 B1	1.53	.629
Pair 12	L12 A	2.60	1.037	Pair 12	L12 A1	2.60	1.037
	L12 B	1.80	.761		L12 B1	1.80	.761
Paired samples test							
Examiner 1		t	'p' value	Examiner 2		t	'p' value
Pair 1	L1 A-L1 B	7.577	.000	Pair 1	L1 A1-L1 B1	5.473	.000
Pair 2	L2 A-L2 B	5.135	.000	Pair 2	L2 A1-L2 B1	10.790	.000
Pair 3	L3 A-L3 B	8.515	.000	Pair 3	L3 A1-L3 B1	8.332	.000
Pair 4	L4 A-L4 B	4.065	.000	Pair 4	L4 A1-L4 B1	5.950	.000
Pair 5	L5 A-L5 B	6.530	.000	Pair 5	L5 A1-L5 B1	8.449	.000
Pair 6	L6 A-L6 B	4.011	.000	Pair 6	L6 A1-L6 B1	6.886	.000
Pair 7	L7 A-L7 B	5.460	.000	Pair 7	L7 A1-L7 B1	6.530	.000
Pair 8	L8 A-L8 B	7.047	.000	Pair 8	L8 A1-L8 B1	7.918	.000
Pair 9	L9 A-L9 B	6.500	.000	Pair 9	L9 A1-L9 B1	7.370	.000
Pair 10	L10 A-L10 B	4.539	.000	Pair 10	L10 A1-L10 B1	4.539	.000
Pair 11	L11 A-L11 B	6.496	.000	Pair 11	L11 A1-L11 B1	6.496	.000
Pair 12	L12 A-L12 B	6.595	.000	Pair 12	L12 A1-L12 B1	6.595	.000
The difference between A & B is significant B for all 12.PD readings. Mean is higher in A Group compared to B Group B or examiner 1. The difference between A1 & B1 is significant B1for all 12.PD readings. Mean is higher in A1 Group compared to B1 Group B1or examiner 2.							

to be examined by examiner 1 & 2. Accordingly the subjects were divided into 4 groups under each examiner.

Comparison of the data by paired t test between Group A & B, Group A₁ & B₁ suggested that the difference between A & B, A₁ & B₁ are significant for all readings. Mean is higher in Group A compared to Group B and Group A₁ in comparison to Group B₁ (Fig. 4) (Table 1).

Similarly while comparing the data in between Group C & D, Group C₁ & D₁, a significant result was observed between Group C & D with mean higher in Group C & C₁ (Fig. 5)(Table 2). These results suggested that the readings of probing depth & clinical attachment level were more accurate in Florida probing system & CEJ Probe (component of Florida probe system).

Difference between A & B is significant for all twelve PD readings. Mean is higher in Group A compared to Group B for examiner 1. The difference between A₁ & B₁ is significant for all twelve PD readings. Mean is higher in Group A₁ compared to

Group B₁ for examiner 2. The difference between C & D is significant for all 12 CAL readings. Mean CAL was higher in Group C compared to Group D for examiner 1. The difference between C₁ & D₁ is significant for all 12 CAL readings. Mean is higher in C₁ Group compared to D₁ Group for examiner 2. The difference between two examiners is significant for L6 CAL readings. Mean is higher for examiner 1. Difference between two examiners is significant for L2, L3 & L4 PD readings. Mean is higher for examiner 2.

On comparing the CEJ probe and Williams periodontal probe, CEJ probe performed better than Williams periodontal probe. The CEJ Probe has potential to perform more accurately for intra examiner consistency.

Inter examiner comparisons

This study involved recording of all the parameters by two examiners which are tabulated. The data collected from Group

Fig. 5 – Mean clinical attachment levels in mm in Group C, Group D, Group C₁ & Group D₁ at locations 1 to 12.

A were compared with Group A₁, B with B₁, C with C₁ and D to D₁ to exclude the inter examiner bias (Figs. 4 and 5). It was observed that the difference between the two examiners was significant for three readings of “p” value and mean was higher for examiner 2. Comparisons of Group C & C₁ showed that the difference between the two examiners was significant for only one CAL readings. Mean was higher for examiner 1. The results after inter examiners comparison confirmed that CEJ probe is most consistent as examiner changed during probing. CEJ probe has shown to be having the most potential consistency than Williams periodontal probe.

Inter examiner reliability Alpha value was calculated. CEJ probe was most consistent as examiner changed during probing. CEJ probe has shown best potential of consistency than Williams periodontal probe (Table 3 a & b).

Discussion

The word probe is derived from the Latin word “Probo” which means “to test.” Periodontal probes are used primarily to detect and measure periodontal pockets and clinical attachment loss. In addition, they are also used to locate calculus, measure gingival recession, measure width of attached gingiva, assess size of intraoral lesions, identify tooth and soft-tissue anomalies, locate and measure furcation involvements, determine mucogingival relationships and bleeding tendencies.⁹ However, periodontal probing has its limitations. Reading errors may result from naturally occurring states, such as interference from the calculus on the tooth or root surface, the presence of an overhanging restoration or the crown's contour. Another factor is operator error such as incorrect angulation of the probe, the amount of

pressure applied to the probe, misreading the probe, recording the data imprecisely and miscalculating the attachment loss.¹⁰

The use of constant pressure probes has advantages over the use of manual probe. The constant pressure probe provide a constant probing force which may serve to limit some of the errors associated with probe penetration. Constant pressure probes have the capacity for electronic data collection eliminating transcription errors with higher resolution than the manual probes. The resolution is the finest increment the probe can be read to. The resolution of a manual probe is generally 1 mm and is limited by 1 mm markings on the probe where as the resolution of the Florida Probe is .1 mm and is determined by its electronics. The resolution does not necessarily relate to the reproducibility or accuracy of the electronic probe. The reproducibility is how a probe could give the same measurement every time; therefore being highly reproducible.

Out of sixty subjects selected in the study, thirty were with generalized severe chronic periodontitis and 30 subjects with healthy periodontium. Selection of subjects with healthy and diseased periodontium were subsequently examined randomly to avoid the bias arising out of examining only healthy or diseased periodontium.

In our study, the CEJ Probe (component of Florida probe system) appeared to possess the greater potential for consistency in attachment level than Williams probe. Florida probe possess greater consistency in probing depth than Williams probe within Intra and between Inter-Examiners (two examiners). The difference in intra examiner consistency between CEJ probe, Florida probe and Williams probe was small. Data demonstrated that the CEJ and Florida probe were more consistent statistically. The result from present study are

Table 2 – Comparison of CAL measured by Williams probe and CEJ probe by examiner 1 & examiner 2.

Paired t-test CAL–examiner 1 & examiner 2							
Examiner 1		Mean	Std. deviation	Examiner 2		Mean	Std. deviation
Pair 1	L1 C	6.03	2.798	Pair 1	L1 C1	5.80	2.511
	L1 D	4.60	2.328		L1 D1	4.60	2.328
Pair 2	L2 C	4.20	2.987	Pair 2	L2 C1	4.17	2.755
	L2 D	3.00	2.421		L2 D1	3.00	2.421
Pair 3	L3 C	4.80	1.972	Pair 3	L3 C1	4.63	1.903
	L3 D	3.33	1.845		L3 D1	3.33	1.845
Pair 4	L4 C	3.90	1.583	Pair 4	L4 C1	4.00	1.390
	L4 D	2.47	1.479		L4 D1	2.47	1.479
Pair 5	L5 C	3.50	1.676	Pair 5	L5 C1	3.70	1.442
	L5 D	2.20	1.243		L5 D1	2.20	1.243
Pair 6	L6 C	3.90	2.023	Pair 6	L6 C1	3.23	2.029
	L6 D	2.37	1.810		L6 D1	2.37	1.810
Pair 7	L7 C	4.13	2.193	Pair 7	L7 C1	4.13	2.193
	L7 D	2.80	1.827		L7 D1	2.80	1.827
Pair 8	L8 C	3.23	1.942	Pair 8	L8 C1	3.23	1.942
	L8 D	2.10	1.517		L8 D1	2.10	1.517
Pair 9	L9 C	3.83	1.783	Pair 9	L9 C1	3.83	1.783
	L9 D	2.47	1.717		L9 D1	2.47	1.717
Pair 10	L10 C	3.47	1.676	Pair 10	L10 C1	3.47	1.676
	L10 D	2.17	1.262		L10 D1	2.17	1.262
Pair 11	L11 C	3.27	1.660	Pair 11	L11 C1	3.27	1.660
	L11 D	1.90	1.296		L11 D1	1.90	1.296
Pair 12	L12 C	3.47	1.676	Pair 12	L12 C1	3.47	1.676
	L12 D	2.13	1.383		L12 D1	2.13	1.383
Paired Samples test							
Examiner 1		t	'p' value	Examiner 2		t	'p' value
Pair 1	L1 C–L1 D	10.785	.000	Pair 1	L1 C1–L1 D1	7.761	.000
Pair 2	L2 C–L2 D	7.761	.000	Pair 2	L2 C1–L2 D1	7.663	.000
Pair 3	L3 C–L3 D	10.351	.000	Pair 3	L3 C1–L3 D1	9.497	.000
Pair 4	L4 C–L4 D	10.785	.000	Pair 4	L4 C1–L4 D1	11.500	.000
Pair 5	L5 C–L5 D	10.140	.000	Pair 5	L5 C1–L5 D1	11.238	.000
Pair 6	L6 C–L6 D	12.324	.000	Pair 6	L6 C1–L6 D1	6.500	.000
Pair 7	L7 C–L7 D	10.269	.000	Pair 7	L7 C1–L7 D1	10.269	.000
Pair 8	L8 C–L8 D	7.999	.000	Pair 8	L8 C1–L8 D1	7.999	.000
Pair 9	L9 C–L9 D	10.420	.000	Pair 9	L9 C1–L9 D1	10.420	.000
Pair 10	L10 C–L10 D	8.510	.000	Pair 10	L10 C1–L10 D1	8.510	.000
Pair 11	L11 C–L11 D	10.420	.000	Pair 11	L11 C1–L11 D1	10.420	.000
Pair 12	L12 C–L12 D	11.050	.000	Pair 12	L12 C1–L12 D1	11.050	.000
The difference between C & D is significant for all 12 CAL readings. Mean is higher in C Group compared to D Group for examiner 1. The difference between C1 & D1 is significant D1 for all 12.CAL readings. Mean is higher in C1 Group compared to D1 Group D1 or examiner 2.							

consistent with those presented by Preshaw et al (1999)¹¹ and Karpinia et al (2004).¹²

Various factors such as probe-tip size, angle of insertion of the probe, probing pressure, precision of probe calibration and degree of inflammation in the underlying periodontal tissues affect the sensitivity and reproducibility of measurements. Because the probe passes through the junctional epithelium into the underlying connective tissue in an inflamed gingival sulcus, readings of clinical pocket depth obtained with the periodontal probes do not normally coincide with the measurements up to the base of the pocket.¹³

Sequential probing of periodontal attachment remains the most commonly utilized method to diagnose progressive destruction of the periodontium. The probing itself is the heart of the problem and many improvements have been sought.^{10,14,15} The pressure applied at the probe tip is a

function of the probing force. Therefore as the probe force increases the CAL measurements also tend to increase. However the actual penetration of the probe tip into the epithelial attachment or underlying connective tissue is influenced to a great extent by the diameter and shape of the probe tip. The probing pressure at the probe tip is then proportional to probe force and inversely proportional to probe tip diameter. Ultimately the penetration of the periodontal probe at the base of the pocket is due to a combination of probe tip design, probing force and the inflammatory condition of the connective tissue at the base of the pocket.^{16,17} In our study healthy and diseased subjects have been included to rule out bias due to change in the condition of the connective tissue at the base of the pocket. In addition to this, study has shown that constant probe system (Florida probe) has given superior results to manual Williams

Table 3 – Inter examiner (examiner 1 and 2) reliability.

Inter examiner (examiner 1 and 2) reliability – alpha				
Number	W		F	
	Correlation	Alpha	Correlation	Alpha
a) For PD –				
L1	.8914	.9233	1.0	1.0
L2	.9100	.9439	1.0	1.0
L3	.7418	.8509	1.0	1.0
L4	.8220	.8992	1.0	1.0
L5	.8559	.9143	1.0	1.0
L6	.8182	.8800	1.0	1.0
L7	.8000	.8863	1.0	1.0
L8	.8243	.8923	1.0	1.0
L9	.8896	.9396	1.0	1.0
L10	1.0	1.0	1.0	1.0
L11	1.0	1.0	1.0	1.0
L12	1.0	1.0	1.0	1.0
b) For CAL –				
L1	.9289	.9602	1.0	1.0
L2	.9719	.9841	1.0	1.0
L3	.9264	.9614	1.0	1.0
L4	.8777	.9306	1.0	1.0
L5	.9201	.9527	1.0	1.0
L6	.9384	.9682	1.0	1.0
L7	1.0	1.0	1.0	1.0
L8	1.0	1.0	1.0	1.0
L9	1.0	1.0	1.0	1.0
L10	1.0	1.0	1.0	1.0
L11	1.0	1.0	1.0	1.0
L12	1.0	1.0	1.0	1.0

periodontal probe in measuring the pocket depth and CAL accurately.

This probing method combines the advantages of constant probing force with precise electronic measurement and computer storage of data, thus eliminating the potential errors associated with visual reading and the need for an assistant to record the measurements. These automated probes also introduce problems. The probing elements lack tactile sensitivity mainly because of their independent movement which forces the operator to predetermine an insertion point and angle. In the current study a custom made acrylic stent has been used to eliminate the errors of probing because of the change in direction. The manual Williams periodontal probing has shown to produce patient discomfort when compared to constant pressure Florida probing system throughout this study. This may be attributed to the uncontrolled force applied in the manual probe while probing. One common problem was encountered as the underestimation of deep probing depths by the automated probe, which is similar to the study by Perry D A et al 1994.¹⁸

The comparative evaluation between the conventional Williams periodontal probe and Florida probing system in the present study has confirmed that efficacy of Florida probing system for measurement of probing depth and clinical attachment levels is more consistent. It is recommended for multicentre study employing larger numbers of subjects and examiners for further evaluation.

Conflicts of interest

All authors have none to declare.

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