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Evaluation of a new periodontal probe tip design

A clinical and in vitro study

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Abstract

Aims: In the search for an accurate periodontal probe which does not frequently penetrate the pocket base, a new tip has been designed which is flattened, and of 1 mm width and 0.45 mm thickness. This study aimed to evaluate the physico-mechanical and clinical properties of this probe (test) in comparison to a conventional 0.5 mm circular probe (control).

Methods: Photoelastic stress analysis was undertaken for test and control probe tips at 3.15 and 5 N loads. To assess probing validity, the clinical probing depth with each probe (0.25 N force) at 125 sites on 27 teeth (27 subjects), was compared with the post-extraction connective tissue level measurement. Also evaluated were probing reproducibility (1200 sites in 25 subjects) and patient comfort (30 subjects).

Results: Using photoelastic stress analysis, the test probe demonstrated lower stresses and less local stress concentration than the control. Clinically, the test probe measured close to the post-extraction gold standard in greater frequency than the control – 26 versus 11 readings (21% versus 9%) exactly matched, and 90 versus 67 (72% versus 54%) were within $\pm$ 0.5 mm of the laboratory measurement. The test probe was, on average, 0.13 mm coronal to the connective tissue attachment level, whereas the control penetrated 0.27 mm past this level. The intraclass correlation between clinical and laboratory readings was greater for the test than the control ($r = 0.81$ and 0.74, respectively). Although the control probe overestimated probing depth more markedly at bleeding (0.41 mm) than at non-bleeding (0.15 mm) sites, the relative position of the test probe hardly differed with inflammatory status (-0.11 and -0.14 mm, respectively). Each probe demonstrated good clinical reproducibility. However, the test probe examination was more comfortable for the patient.

Conclusion: This new periodontal probe tip appears to have greater validity, good reproducibility and produces less patient discomfort.

Key words: periodontal probe; probe penetration; stress analysis

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For over a century, the periodontal probe has played an integral part in the periodontal examination and the detection of periodontal disease. Its use not only enables treatment to be planned appropriately, but also facilitates longitudinal monitoring so that the response to treatment may be assessed and sites of possible disease progression identified. Yet, periodontal probing is an imprecise technique with several potential sources of error (Watts 1987, 1989a,b).

The periodontal probe is advanced until the pressure exerted is equally opposed and resisted by the underlying periodontal tissues – probing depth is measured at this point. Consequently, the two main determinants of probe tip position at the base of the pocket are probing pressure (Aguero et al. 1995), which is related to the shape and dimension of the probe tip (probe tip area), and probing force (Robinson & Vitek 1979, van der Velden 1979, 1980, van der Velden & Jansen 1981, Mombelli et al. 1992), and status of the periodontal tissues. Most research has shown that the tendency for penetration of the probe into the tissues at the base of a pocket giving an over-estimate of probing depth is greater at inflamed sites (Armitage et al. 1977, Robinson & Vitek 1979, Magnusson & Listgarten 1980, Hancock & Wirthlin 1981, Jansen et al. 1981, Fowler et al. 1982, van der Velden 1982, Clerehugh & Lennon 1984, Keagle et al. 1989) and in non-smokers (Biddle et al. 2001).

Studies have investigated the probing validity of various probing systems. The majority have used probes with a circular cross-section, assessing the influence of a variety of tip diameters, probing forces or a combination of both. Whereas Polson et al. (1980), using a probing pressure of 260 N/cm^2 (0.35 mm probe tip and 0.25 N force), found that the probe extended only as far as 0.25 mm coronal to the apical end of junctional epithelium, van der Velden (1979) reported that a lesser probing pressure of 241 N/cm^2 (0.63 mm probe tip and 0.75 N force) was optimal to reach the most coronal ''intact'' connective tissue fibres. In a contrasting study by Spray et al. (1978), lower forces resulting in approximate probing pressures of only 120–160 N/cm^2 were found to penetrate even further, 0.27 mm into the connective tissues. Comparison of these and other, more recent, studies does not reveal any trend or agreement regarding the optimal probing pressure or probing system to consistently measure the coronal margin of the connective tissue attachment.

In the search for an instrument with a reduced likelihood of penetrating the base of a pocket and a greater degree of validity, a new periodontal probe has been designed with a 1 mm wide, flattened tip (of 0.45 mm thickness). In contrast with the conventional 0.5 mm circular probe design, the new probe has an increased tip area (giving less pressure at similar forces), an altered shape (potentially giving less pressure concentration at similar pressures) and a high area/volume ratio (theoretically enabling the probe to reach the base of the pocket unhindered).

This study aimed to compare this new periodontal probe tip design and a conventional 0.5 mm circular probe with regard to:

- physico-mechanical properties (in vitro) using photoelastic stress analysis;
- clinical properties:
  - validity of probing
  - reproducibility of probing
  - patient comfort.

Material and Methods

The study was undertaken in the Department of Periodontology and Preventive Dentistry at Guy's, King's and St Thomas' Dental Institute. Ethical Committee approval was obtained and all volunteers gave informed written consent.

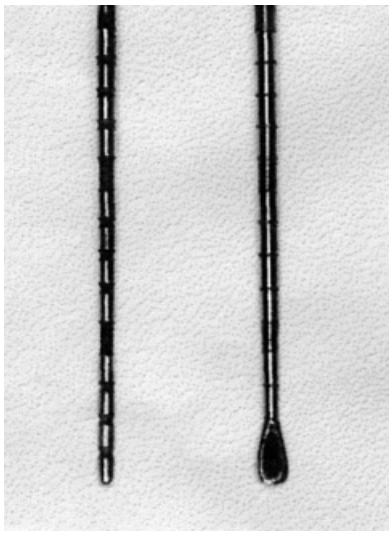

Fig. 1. Control (PCP-UNC 15) and test probes.

Probing system

The University of North Carolina probe (PCP-UNC 15, Hu-Friedy Manufacturing Co, Chicago, IL, USA) served as the control. The test probe differed only in the size and shape of the first 2 mm of the probe tip. Instead of the 0.5 mm rounded tip, it was 1 mm wide, flattened (0.45 mm thick) and with rounded edges (Fig. 1).

The test and control tips were mounted into metal shanks to fit the calibrated Vine Valley pressure-sensitive probing device (Vine Valley Research, Middlesex, NY, USA) for the application of 0.25 N constant probing forces. When using the test probe, the flat surface of the tip would be positioned against the tooth. This was facilitated by mounting the test probe obliquely in its metal shank.

The calibration marks of each probe were checked microscopically and confirmed to be accurate. The exact dimensions of the actual probe tips used in the study were 0.98 by 0.45 mm for the test and 0.52 mm for the control, giving respective cross-sectional probe tip areas of 0.35 and 0.21 mm^2 and probing pressures (at 0.25 N force) of 72.2 and 117.7 N/cm^2, respectively.

Photoelastic stress analysis

Photoelastic stress analysis – a technique first described in dental literature by Noonan in 1949 – utilises the property of birefringence of photoelastic resins in which internal stresses may be visualised under polarised light as coloured patterns. The bands of colour (known as fringes) arise in a specific sequence and represent the magnitude of birefringence, which is directly proportional to the level of stress within the resin. In this study, the method was used to analyse the stress patterns (magnitude, location and concentration) at loaded test and control probe tips and thus compare the physical impact of the probes.

The manufacturer's instructions were followed in the preparation of identical blocks of PL-3 photoelastic resin (Measurements Group Inc, Raleigh, NC, USA) each with either the test or control probe tip embedded axially up to the 5 mm mark. For each probe tip, two blocks were prepared, one with the probe in front view and one showing the side view.

Under white light, the blocks were visualised in a transmission polaroscope (light-field) both under unloaded conditions and with the probe tips subject to axial loads of either 3.15 or 5 N (sufficient to produce a fringe pattern for interpretation). The resultant images were recorded on digital camera (Nikon Coolpix 990, Nikon Corporation, Tokyo, Japan) and analysed.

Validity of probing

Twenty seven subjects scheduled to have a tooth extraction for periodontal, endodontic or prosthetic reasons were invited to participate in the study. Measurements per subject were limited to only one tooth (and a maximum of six sites) so as to minimise possible subject bias. Smoking history was recorded according to the number of cigarettes smoked per day and duration of the habit. Pregnancy was the only medical exclusion criterion.

A record was made of the mobility of the tooth scheduled for extraction. Subsequently, local anaesthesia was administered using, where possible, block anaesthesia so as to avoid a local vasoconstrictive effect which may influence probing bleeding status. Up to six vertical steering grooves were cut in the tooth with a tapered diamond bur, terminating exactly at the gingival margin. The grooves were placed at mesial, mid-and distal regions on buccal and lingual/palatal surfaces. Where a furcation defect was anticipated, the

groove was either cut in an adjacent area avoiding the furcation or excluded altogether. These grooves served not only as direction indicators for clinical and laboratory recording, but also as indicators of the gingival margin level for the post-extraction laboratory measurements.

At each groove, the test or control probe was used with a constant probing force of 0.25 N to measure probing depth (to the nearest 0.5 mm) from the base of the groove (gingival margin). Thirty seconds after probing, bleeding status was also recorded with a dichotomous bleeding score. Following an interval of at least half an hour, and without access to the original data, these probing depth and ''bleeding on probing'' measurements were repeated with the second of the two probes (test or control). Randomisation of the order of probing was achieved with a ''paired coin toss''.

Once all the clinical measurements were complete, the tooth was extracted atraumatically with forceps and stored in 10% formal saline.

Using Gomori's rapid one-step trichrome stain (Gomori 1950) with a modified technique to enhance visibility of the stained area (7 min stain, 5 min wash-out), the connective tissue attachment and frequently the ''plaque-free zones'' were rendered visible on the extracted tooth. Under a dissecting stereo-microscope ($\times$ 20 magnification), calibrated electronic Vernier callipers (Brown & Sharpe™, Renens, Switzerland) were used to measure, to the nearest 0.1 mm, from the apical limit of each steering groove to the most coronal connective tissue attachment level. This laboratory measurement represented the gold standard probing depth, to which the clinical probing depth readings for each probe were compared in order to assess validity. The laboratory measurements were repeated to give an evaluation of reproducibility. However, only the first set of recordings was used for clinical comparison. The position of any calculus was also recorded. No clinical data were available to the examiner during laboratory measurement.

Probing reproducibility

Probing reproducibility was assessed on 25 randomly selected subjects with varying levels of periodontal disease.

In each subject, probing depth measurements were recorded to the nearest 0.5 mm, using a 0.25 N constant probing force, at six sites on each of eight teeth, four with the test probe and four with the control. After half an hour, without access to the first set of readings, these probing depth measurements were repeated.

Within the total sample, data were collected for each probe (test and control) in equal frequency from all sextants.

Patient comfort

Patient perception of probing with test and control probes was assessed using a 10 cm visual analogue scale (VAS) labelled on its left with the words ''no pain or discomfort whatsoever'' and on its right ''worst pain/discomfort imaginable''. The VAS scale was explained to the subject.

In each of 30 subjects, using a 0.25 N force, all sites of one quadrant were probed with one probe (test or control) and a different quadrant was probed with the other. Immediately after each probing, the subject was instructed to put a mark on a VAS line to represent their experience of the probing.

The subject was ''blinded'' as to which probe was which and the order of probing was randomised with a paired coin toss.

Statistical analysis

Statistical analyses of the data on probing validity were carried out using the survey analysis technique with the subject as the primary sampling unit, in order to avoid the lack of independence created by comparison of sites clustered within subjects (site-based analysis). This within-subject statistical analysis was applied to the data as a whole and also to the data subdivided according to inflammatory status and subject's smoking status. The McNemar test for paired readings assessed the significance of any differences in the bleeding scores of the test and control probes.

Intraclass correlation was used to assess the agreement between clinical and laboratory measurements, and the reproducibility of repeated clinical and laboratory measurements. In addition, the 95% limits of agreement (for clinical reproducibility) were calculated from plots (Bland & Altman 1986).

Stepwise linear regression analysis (using both forward and backward models) was used to identify variables that explain the differences between the probes significantly.

The Wilcoxon signed-rank test (matched-pairs test) assessed the significance of differences between the visual analogue scores of the probes.

Results

Photoelastic stress analysis

None of the unloaded blocks exhibited any colour patterns when visualised under polarised light, confirming the absence of residual birefringence within the resin.

Fig. 2 shows the two probes under a 3.15 N load. Compared with the test probe, there is an additional colour transition from blue/green to yellow beneath the control probe tip. Consequently, the fringe order value at point A is larger (1.39 N) for the control probe than the test probe (1.20 N) indicating a higher stress level beyond the control probe tip.

In Fig. 3 the probes are seen in ''side view'' subject to a 5.0 N load. There is a greater number of sequential coloured bands below the control tip than at the test probe, indicative of a higher magnitude of stress. This is endorsed by the fringe order measurements at points A and B, which are consistently higher for the control probe (3.10 and 2.35 N) than for the test probe (2.65 and 1.39 N). Despite the colour patterns of the test probe appearing somewhat irregular (possibly due to a slightly rotated force application), the coloured bands are generally wider indicating a greater distribution of the load from the test probe than at the control probe which, with narrower bands in close proximity, has instead a steeper strain gradient and higher stress concentration local to the probe tip.

Validity of probing

The 27 recruited subjects (12 of which were male) had an age range of 31–74 (mean: 48) years. Eleven were current smokers with a mean pack-year number of 17.5 (SD: 17.2); and 16 were ''never smokers''. There were 27 teeth (21 molars) with a total of 125 sites, relatively evenly distributed between the different surfaces on teeth. The mean number of sites per subject was 4.63 (SD: 1.36). Reasons for site exclusion were radiographic or laboratory identification of a furcation defect,

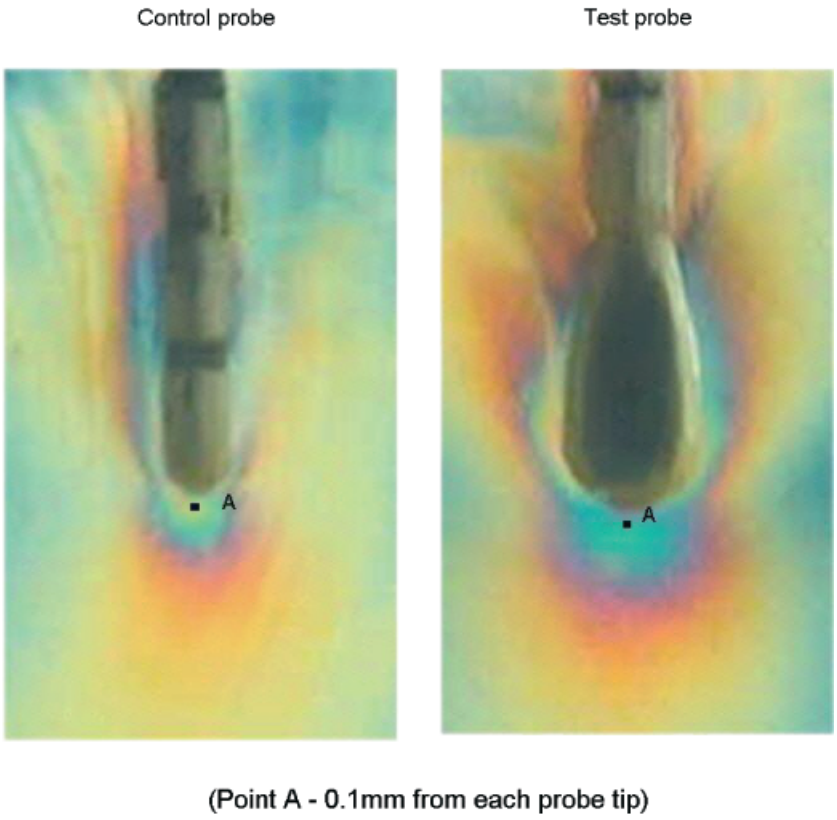

Fig. 2. Light-field photoelastic images of probes subject to a 3.15 N load.

fracture of a root during extraction and poor clarity of connective tissue staining.

The actual probing depths (represented by the laboratory measurement) varied from 0.7 to 12.0 mm, with over half the sites (65) deeper than 3 mm. The laboratory readings showed a high level of measurement reproducibility with a correlation coefficient of 0.999 (estimated reliability 99.9%).

The differences between the clinical probing measurements (test or control) and the gold standard laboratory connective tissue measurements are shown in Fig. 4. One outlier has been excluded from each histogram – at the very same site (a site with heavy deposits of subgingival calculus), the control probe fell short of the connective tissue attachment level by 9 mm, and the test probe similarly underprobed by 10 mm. Fig. 4 shows that the test probe measured close to the post-extraction gold standard in greater frequency than the control – 26 readings (21%) in contrast to 11 (9%) exactly matched, and 90 (72%) versus 67 (54%) were within ± 0.5 mm of the laboratory measurement. The histograms also show that when there was a discrepancy between clinical and laboratory readings, the test probe was equally likely to overprobe as underprobe (proportions of positive and negative differences were 38% and 41%, respectively), whereas the control probe had a greater tendency to overprobe (55% versus 36%). Despite this, the number of readings significantly underestimating probing depth (with a negative difference of more than 1 mm) was still almost the same for each probe – 11 with the control and 12 with the test. Of the total 125 readings with each probe, only two readings with the test probe differed from the gold standard by more than 4 mm, while the corresponding number for the control probe was 5.

At 81 sites, the readings of the two probes did not match each other – 80% of these discrepancies were due to the control probe measuring deeper than the test probe. There was a mean difference of 0.40 mm (SD: 0.87) between the clinical probing measurements of the two probes.

The mean probing depth with the test probe was 3.69 mm (SD: 2.20), marginally less than the mean laboratory measurement of the connective tissue attachment: 3.82 mm (SD: 2.28). In contrast, the corresponding value for the control probe was greater than the laboratory gold standard, at 4.08 mm (SD: 2.28), suggesting a greater tendency to penetrate the connective tissue.

The means of the differences between paired clinical and laboratory readings for each site are shown in Table 1. The results reveal that the test probe had a smaller mean difference than the control, indicating that on average the test probe was closer to the true probing depth – 0.13 mm coronal to the gold standard, as opposed to 0.27 mm apical to it. The difference between control probe and laboratory measurements was approaching statistical significance ($p = 0.082$), whereas the test probe revealed no statistically significant difference ($p = 0.419$) from the laboratory readings. In accordance with the above, there was a higher intraclass correlation and greater agreement between the test probe and laboratory readings ($r = 0.81$, estimated reliability 90%) than between the control probe and laboratory measures ($r = 0.74$, estimated reliability 85%). The difference in the results between probes was found to be highly statistically significant ($p < 0.001$).

Bleeding status

The frequency of bleeding on probing was higher with the control probe (58, 46.4%) than with the test probe (47, 37.6%). The number of sites bleeding with the control but not the test probe was almost double (23, 18.4%) that of the sites bleeding with the test probe alone (12, 9.6%). The enhanced bleeding tendency with the control probe was found to be statistically significant ($p < 0.05$).

The results for the control probe after data segregation into bleeding and non-bleeding sites show that, on average, the probe penetrated further into the tissues if there were bleeding and inflammation than if there were not. The mean differences between clinical and laboratory measurements were 0.41 mm (SE: 0.30) at bleeding sites compared with 0.15 mm (SE: 0.12) at non-bleeding sites. In contrast, the results for the test probe at its own bleeding and non-bleeding sites reveal that the average probe position relative to the gold standard was almost identical whether there was bleeding or not, with mean differences (SEs) of -0.11 mm (0.36) and -0.14 mm (0.12) at bleeding and

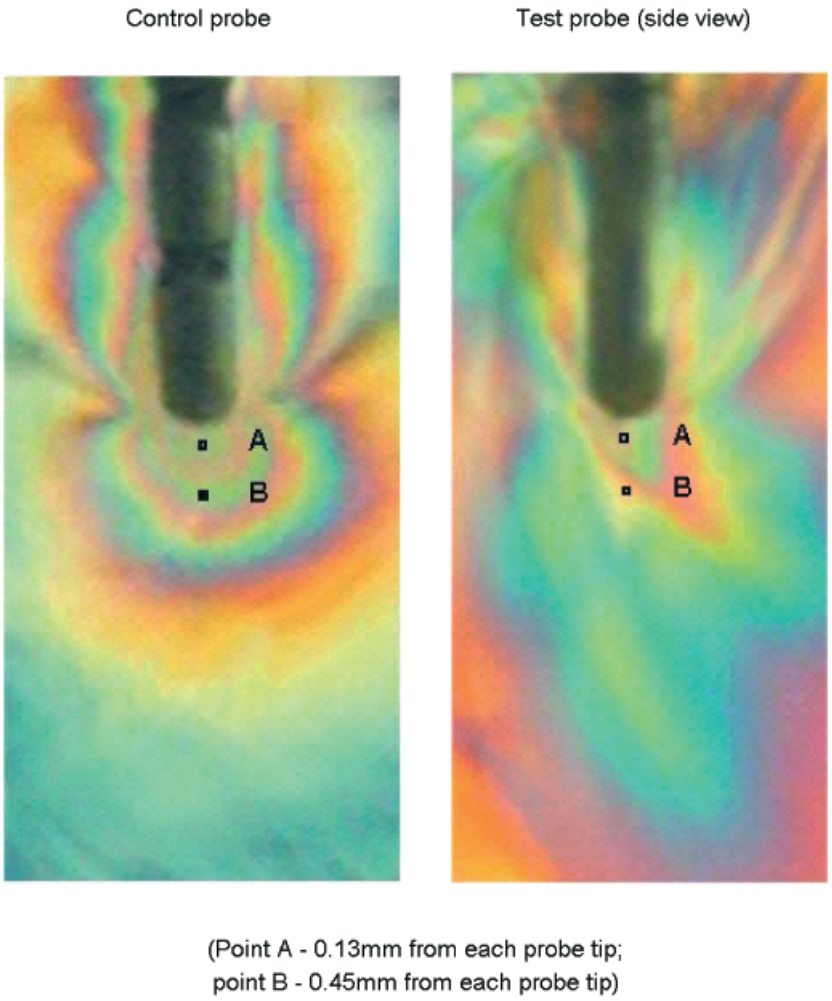

Fig. 3. Light-field photoelastic images of probes subject to a 5.0 N load.

non-bleeding sites, respectively. This appears to suggest that the test probe was equally valid irrespective of inflammatory status.

In addition to evaluation of the probes separately at their own bleeding and non-bleeding sites (see above), the two probes were directly compared at matched sites where bleeding status was determined by the control probe. These results are shown in Table 2. Although both probes had a greater standard error for mean differences at bleeding sites indicating greater variability, the average measurement for the test probe came closer to the gold standard not only at bleeding sites (-0.24 versus 0.41 mm) but also at non-bleeding sites (-0.03 versus 0.15 mm). The difference between the two probes was statistically significant both at bleeding ($p<0.001$) and non-bleeding sites ($p=0.023$). However, the p values indicate a much higher significance where there was bleeding.

Smoking status

The 16 non-smoking subjects contributed 73 sites to the study, 37 non-bleeding and 36 bleeding. In the 11 smokers, there was a greater frequency of non-bleeding (30) than bleeding sites (22).

The difference between the two probes was of greater statistical significance in the non-smokers ($p<0.001$) than smokers ($p=0.032$).

Regression analysis

Stepwise linear regression analysis revealed that bleeding status on probing ($p=0.001$) and cigarette pack-years ($p=0.029$) had a significant explanatory effect on the difference between the test and control probes, whereas variables such as probing depth, mobility, tooth type, tooth surface (site), order of probing (test or control first), subject age and gender did not.

Probing reproducibility

The 25 subjects on which probing reproducibility was investigated, ranged in age from 25 to 85 years, and of these 10 were male. A total of 600 sites were probed with each probe, with probing depths ranging between 0 and 10 mm for the control probe and 1 and 8 mm for the test probe.

Table 3 shows the cumulative proportion of sites with repeated readings lying within 0, 1 and 2 mm of the original. Both probes showed a high level of reproducibility: 64% of repeated readings with the control probe exactly matched, and 70% with the test probe. These results correspond to high intraclass correlation coefficients, 0.83 for the control probe (estimated reliability 91%) and 0.81 for the test probe (estimated reliability 90%). The 95% limits of agreement were -1.59 to $+1.48$ and there was no relationship between the difference between the probes and the depth of pocket being measured.

Patient comfort

Patient perception of probing was investigated in 30 subjects (12 male, 18 female) of ages 25–74 years.

Using the VAS, 22 subjects indicated that the control probe was more uncomfortable/painful than the test probe; the trend was reversed in three individuals; and the remaining five found no difference between the probes.

Table 4 shows that although the scores out of a maximum of 100 were relatively low for both test and control probes, the mean score for the control probe (13.35) was more than double that of the test probe (5.87). The difference between the probes was found to be highly statistically significant ($p<0.001$).

Discussion

In considering the validity of periodontal probing the principal question is What is the ideal probe position? There are essentially two standpoints: Listgarten (1972) has defined the base of a pocket as the coronal border of the connective tissue attachment, and the majority of authors of probing validity studies, including van der Velden (1979), van der Velden & Jansen (1981) and Barendregt et al. (1996), have aimed to measure to this level. In theory, recording to the connective

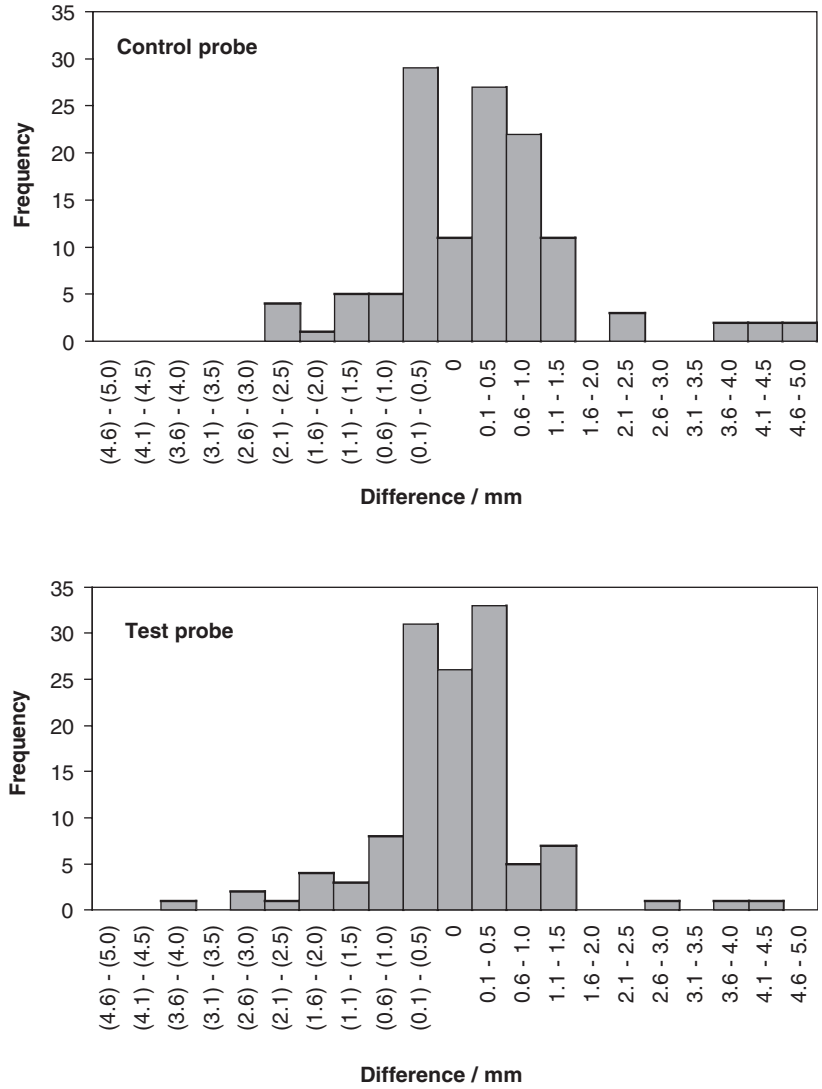

Fig. 4. (a, b) Frequency distribution of differences between clinical and laboratory measurements for the control and test probes (positive difference: clinical measurement > laboratory measurement; negative difference: clinical measurement < laboratory measurement).

Table 1. Difference between clinical and laboratory probing depth readings

Probe	Mean difference in mm (SE)	95% confidence intervals	*p* value	
control	0.27 (0.15)	− 0.04 to +0.57	0.082	<0.001
test	− 0.13 (0.16)	− 0.45 to +0.19	0.419	

Table 2. Difference between clinical and laboratory probing depths in relation to bleeding status using the control probe

Bleeding on probing	Subjects (sites)	Probe	Mean difference in mm (SE)	95% CI	*p* value
no bleeding	25 (67)	control	0.15 (0.12)	− 0.11 to +0.40	0.023
		test	− 0.03 (0.09)	− 0.22 to +0.16	
bleeding	24 (58)	control	0.41 (0.30)	− 0.21 to +1.03	<0.001
		test	− 0.24 (0.30)	− 0.86 to +0.39	

tissue attachment would enable evaluation of the presence of new connective tissue following therapy. However, other authors have sought to probe only as far as the base of the histological sulcus (coronal limit of the junctional epithelium), which would allow identification of clinical attachment level gains secondary to adherence of a long junctional epithelium or improved connective tissue tonus with periodontal treatment (Polson et al. 1980, Garnick et al. 1989, Keagle et al. 1989).

Comparison of existing probing validity studies in the literature fails to reveal any pattern between associated probing pressures and clinical probe penetration. There is no apparent consensus as to the ideal system or probing pressure for consistently accurate measurement of probing depth.

The present study investigated a new design of periodontal probe with a 1 mm wide, flattened tip used with a 0.25 N force. The average position of the test probe was 0.13 mm coronal to the level of the connective tissue attachment, while the control probe (with a tip of 0.5 mm diameter) was 0.27 mm apical to this gold standard. The result for the control probe (with a probing pressure of 118 N/cm^2) is highly comparable with the 0.27 mm overestimation reported by Spray et al. (1978) using probing pressures of 120–160 N/cm^2; meanwhile, that of the test probe is perhaps more in accordance with the results reported for conventional probes at sites with minimal or no disease and inflammation, where the probe penetrates the junctional epithelium but stops short of its apical termination (Armitage et al. 1977).

With regard to probing validity, the results revealed the new probe to be superior to the control, as a consequence of its measuring close to the gold standard in greater frequency, having fewer outlier measurements (readings > 4 mm from the gold standard), lying on average closer to the gold standard, and correlating statistically more closely with the gold standard.

What explanation can be offered for these findings? The test probe, with its larger cross-sectional tip area (0.35 mm^2 compared with 0.21 mm^2), would exert a lower probing pressure (72.2 N/cm^2) than the control (117.7 N/cm^2) at identical probing forces of 0.25 N. It would not be unexpected, therefore, for the test probe to penetrate less deeply into the underlying periodontal tissues.

Table 3. Clinical probing reproducibility (cumulative number and proportion)

Difference between repeated measurements (mm)	Control probe $n = 600$	Test probe $n = 600$
0	383 (64%)	420 (70%)
± 1	551 (92%)	577 (96%)
± 2	586 (98%)	594 (99%)

Table 4. Visual analogue scores for control and test probe

Probe	Mean score (SD)	Median	Range (interquartile range)
control $n = 30$	13.35 (14.25)	7.25	0–50.5 (3–17)
test $n = 30$	5.87 (5.55)	4	0–17 (1–10)

However, this difference in probing pressures may not necessarily account for the greater consistency, less variation and greater overall accuracy of the test probe measurements. Perhaps even more significant than the probing pressure is the difference in the shape of each probe tip which may modify the *pattern* of stress distribution and thus influence the clinical behaviour of the probes. In hypothesis, the connective tissue attachment may be better able to resist advancement of a probe tip which is tending to dissipate rather than concentrate stresses. Using photoelastic stress analysis, this study demonstrated not only that the test probe developed a lower stress magnitude at its tip (under identical loading to the control probe), but that there was also less concentration and a greater distribution of the stress away from the tip. This physicomechanical property, rather than a difference in probing pressure, is likely to be responsible for the improved clinical performance of the test probe.

Most interesting is the finding that whereas, while using the control probe there was a greater degree of penetration of the tissues at bleeding sites than non-bleeding sites (in accordance with studies by Robinson & Vitek 1979, Fowler et al. 1982, Clerehugh & Lennon 1984, Keagle et al. 1989), for the test probe, probing validity did not vary greatly with inflammatory status – there was a similar small level of undermeasurement at bleeding and non-bleeding sites. The results appear to suggest that although this new probe can still identify inflammatory status (through bleeding on probing), variation in tissue inflammation may not bias the associated probing depth measurement, a recognised drawback of conventional probing. If so, the benefit of using the new probe for longitudinal measurements is apparent, not only for the clinician measuring treatment response or stability in maintenance, but also for the researcher and epidemiologist measuring disease activity and true change in attachment level over time.

In light of the different patterns of the behaviour of the two probes according to tissue inflammatory status, it would not be wholly unexpected to find that the difference between the probes was greater (0.65 mm) and even more highly statistically significant at bleeding sites than at non-bleeding sites (0.18 mm). It would also account for the difference between the probes being likewise greater and more statistically significant in the non-smokers than smokers, if as suggested by Preber & Bergstrom (1985), Biddle et al. (2001) and others, there is less inflammation in smokers.

One concern prior to undertaking the study was that the wide test probe would be less able than the conventional probe to access the full depth of a pocket and may, therefore, inadvertently give an undermeasurement. However, this was shown not to be the case, as the frequency of sites underestimating the actual probing depth by more than 1 mm was found to be almost the same for each probe (11 with the control and 12 with the test).

The level of probing reproducibility was high with both probes tested, and whether for reasons of lower pressure or greater distribution of pressures, the new probe was more comfortable and less painful than the conventional probe. In addition, it was found to be less traumatic to the tissues as deduced by the reduced tendency for bleeding on probing.

The only disadvantage of the new probe was that the process of probing was marginally more time consuming than conventional probing due to the need for careful alignment of the probe tip against the tooth.

This new design of periodontal probe may be of particular benefit for use in research where accuracy of measurements on a longitudinal basis is paramount and time factors less critical.

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