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Original Article

Standardization of examiners using a dental model for pocket probe training: Adequacy of evaluation with a model and standard accuracy rate of skilled examiners

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Abstract

Objective: To standardize examiners using a dental model, we developed a dental model and conducted a study that found the model was feasible and effective for student practice. However, it remains unclear whether the skill of measuring probing depth (PD) in this model correlates with the skill of measuring PD in patients. Thus, this study was designed to clarify this point and to determine the accuracy rate of a skilled examiner.
Material and Methods: Study 1: Fifty-one students measured PD in patients with more than 4 teeth having a pocket equal to or deeper than 4 mm and PD in the model. On the same day, their instructor remeasured PD in these patients. Study 2: Ninety-nine students and 11 Certified Periodontists measured PD in the model.
Results: Study 1: The accuracy rate of students measuring patients' PD equal to or deeper than 4 mm and PD in the model showed a significant positive correlation. Study 2: Based on the receiver operating characteristic curve analysis, the accuracy rate equivalent to the skill level of Certified Periodontists was found to be 84.7%.
Conclusion: Standardization of examiners was confirmed with this model. The standard accuracy rate of skilled examiners was found to be 85%.

Key Words: Periodontal pocket; Calibration; Dental models; Periodontics

Introduction

Periodontal probing is an important procedure that allows dentists to evaluate the condition of the periodontal tissues when examining patients with periodontitis. Probing accuracy and precision are affected by probe design, probing force, probe position, pocket depth, and/or tissue inflammation.[1] Thus, in previous studies, to improve probing accuracy and precision, the shape of manual probes,[2, 3] probing force,[4] constant force periodontal probes,[4] intra — and inter-examiner reproducibilities,[1, 5–12] and sources of error for probing[13] have been investigated, and examiners are calibrated by repeatedly measuring the same patient. However, few papers have reported the standardization of examiners using a dental model.

To standardize examiners using a dental model, we developed a new dental model (the model: Nissin 500H-PRO (Nissin Dental Products, Inc., Kyoto, Japan; 500H. PRO, 500HPRO A1 F GSF T6, 500HPRO_P3_#P)) (Figure 1) that simulates the structure of periodontal pockets and then conducted a study that found that the

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Figure 1. Dental model for probing practice used in this study

model was practical and effective for student practice. However, it remains unclear whether the skill of measuring probing depth (PD) in this model corresponds to the skill of measuring PD in patients. Thus, this study was designed to clarify this point and to determine the accuracy rate of a skilled examiner who has the skill equivalent to Board-Certified Periodontists of the Japanese Society of Periodontology (hereafter Certified Periodontists).

Materials and Methods

These studies were approved by the Ethics Committee of Tokyo Medical and Dental University (D2017-034, D2018-012) and were conducted at Tokyo Medical and Dental University (TMDU) in accordance with the Helsinki Declaration of 1975, as revised in 2013. All participants gave their oral, informed consent to participate in these studies.

Study 1: Correlation of the accuracy rate measuring the model and measuring patients

Fifty-one 6th-year students in a clinical practicum at TMDU School of Dentistry (November 2017 to October 2018) measured PD in a patient with more than 4 teeth having a pocket equal to or deeper than 4 mm and PD in the model. Most of these measurements were done within two weeks by each student. They used a manual periodontal probe (Hu Friedy; CP15 UNC). On the same day, their instructor (Certified Periodontist) remeasured PD in the patient. "Correct pocket depth" was defined as the PD measured by the instructor ± 1 mm.

Study 2: Estimation of the standard accuracy rate of Certified Periodontists using a dental model

Ninety-nine 4th-year students at the School of Dentistry, TMDU, in 2017 and 2018, who just started their periodontology course and 11 Certified Periodontists at the Department of Periodontology, TMDU, measured PD in the model. The measurement was done within a day each year. The model was set on a mannequin (Yoshida Dental Trade Distribution Co., Ltd. Tokyo, Japan: Dental training system P 6/3 TLV), and the students and Certified Periodontists used a manual periodontal probe (Hu Friedy; CP15 UNC). To repeatedly measure PD in the model, the method established by Sunaga et al was used. The 24 artificial teeth were divided into four groups of six teeth each, designated as groups A, B, C, and D. Participants probed these groups of teeth according to a randomly assigned order using the six-point method (Figure 2). For each group, participants self-verified their PD against setup depths to improve their probing skill. By repeating this procedure 4 times, they measured a total of 24 teeth. "Correct pocket depth" was defined as the setup depth ± 1 mm.[10–12, 14]

Statistical Analysis

Statistical analyses were performed using SPSS software version 22. The accuracy rate was defined as: number of sites of pockets correctly measured by examiner / number of all sites. Set-up depth was provided by Nissin Dental Products. In study 1, to analyze the correlation of accuracy rate in measuring the model and measuring patients, correlations were identified using the Test of Non-correlations and Spearman's rank correlation coefficient. The results were considered statistically significant at p values <0.05. In study 2, to estimate the standard accuracy rate of Certified Periodontists, receiver operating characteristic (ROC) curve analysis and Youden's index were used. The 1st measurement results by students were set as data of unskilled examiners (negative), and the 4th measurement results of Certified Periodontists were set as data of skilled examiners (positive).

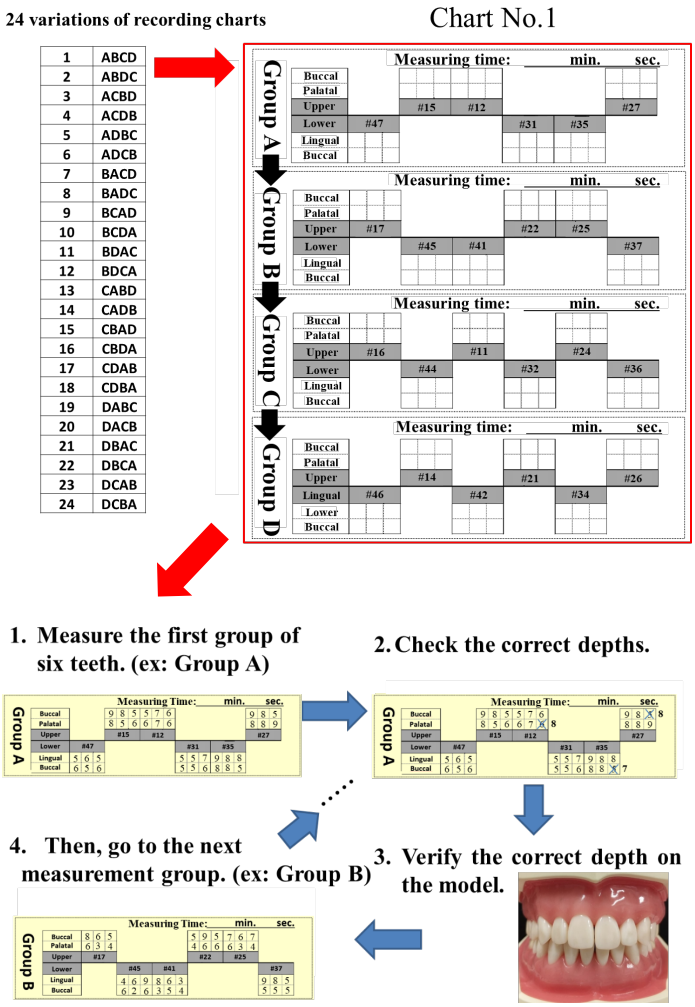

Figure 2. Example of measurement procedure using Chart No. 1 with the order A-B-C-D

Results

Study 1: Correlation of the accuracy rate in measuring the model and measuring patients

A total of 13 students were excluded from the study because 5 were unable to receive their instructor's remeasurement on the same day, 7 could not complete their record of the measurement, and 1 did not get a patient with more than 4 teeth having a pocket equal to or deeper than 4 mm. The data of 38 students were analyzed.

The accuracy rate of 6th-year students measuring PD in a patient (93%, 90–96%: median, interquartile range) and PD in the model (85%, 83–88%) showed a significant positive correlation ($p < 0.05$, $\rho = 0.349$: Test of Non-correlations, Spearman's rank correlation coefficient). The accuracy rate of the 6th-year students measuring patient PD equal to or deeper than 4 mm (70%, 58–82%) and PD in the model (85%, 83–88%) also showed a significant positive correlation ($p < 0.001$, $\rho = 0.550$: Test of Non-correlations, Spearman's rank correlation coefficient) (Figure 3).

Study 2: Estimate of the standard accuracy rate of Certified Periodontists

To estimate the standard accuracy rate of Certified Periodontists, receiver operating characteristic (ROC) curve (Figure 4) analysis and Youden's index (Table 1) were used. The 1st measurement results by students (78%, 67–86%: median, interquartile range) were set as data of unskilled examiners (negative), and the 4th measurement results of Certified Periodontists (89%, 86–92%: median, interquartile range) were set as data of skilled examiners (positive).

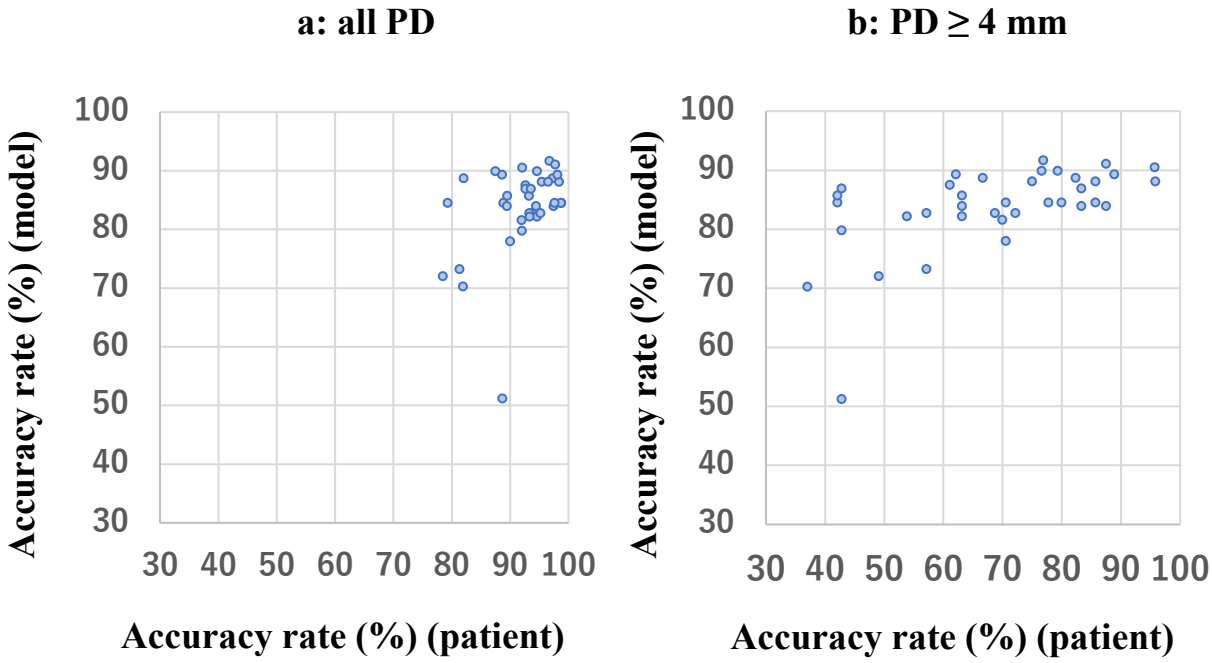

Figure 3.
a: Correlation of the accuracy rates for measuring PD in patients and PD in the model.
b: Correlation of the accuracy rates for measuring patient PD equal to or deeper than 4 mm and PD in the model.

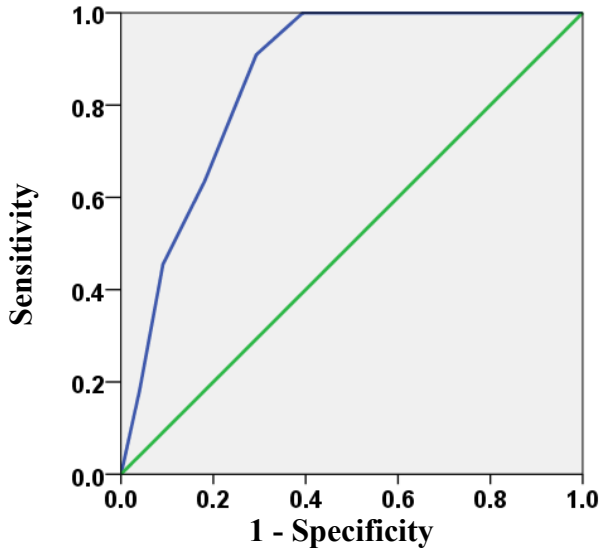

Figure 4. ROC curves drawn for accuracy rates of skilled and unskilled examiners
First measurement results by students were set as data of unskilled examiners, and 4th measurement results by Certified Periodontists were set as data of skilled examiners.

From the maximum value of Youden's index (0.616), the accuracy rate equivalent to the skill level of Certified Periodontists was found to be 84.7%.

Table 1. Youden's index of ROC curves in Figure 4

Accuracy rate	Youden Index
68.1%	0.273
70.8%	0.323
73.6%	0.374
76.4%	0.444
79.2%	0.525
81.9%	0.606
84.7%	**0.616**
87.5%	0.455
90.3%	0.364
93.1%	0.141
100.0%	0.000

From the maximum value of Youden's index (0.616), the accuracy rate that is equivalent to the skill level of Certified Periodontists is 84.7%.

Discussion

Sunaga et al. reported that a dental model was effective for training in periodontal pocket probing and for evaluation and standardization of examiners' probing skills at a preclinical level.[14] However, it was unclear whether the assessment of probing skill using the

model was equivalent to the assessment of probing skill using patients. In the present study, the accuracy rate of 6th-year students measuring their patients and the accuracy rate of 6th-year students measuring the model showed a significant positive correlation. Using the model, it was found that probing skill could be assessed, and examiners could be standardized.

The accuracy rate of 6th-year students measuring patients was relatively high (93%: median). Students could easily get the correct answer because the inclusion criterion for patients was "patient with more than 4 teeth having a pocket equal to or deeper than 4 mm", and most other pockets were less than 4 mm, and the "Correct pocket depth" was set as the setup depth ± 1 mm. The proportion of pockets equal to or deeper than 4 mm was 14%. Depending on the patient, the ratio of pockets equal to or deeper than 4 mm differed, and if it was low, they could obtain higher accuracy rates and their probing skills could be overestimated. Badersten et al., Walsh et al., and Wang et al. reported that intra-examiner reproducibility within ± 1.0 mm in PD measurements using a manual probe ranged from 80 to 97%, and Sunaga et al. set the "Correct pocket depth" of the model as setup depth ± 1 mm.[10-12, 14] The "Correct pocket depth" in the present study was also set as the PD of the instructor ± 1 mm. Hence, PD of less than 4 mm would easily be correct, and the accuracy rate of 6th-year students measuring patients was high. To correct for the overestimation of the skill, the correlation between the accuracy rate of 6th-year students measuring patient PD equal to or deeper than 4 mm and PD of the model was analyzed. This also showed a significant positive correlation.

When aiming to improve probing accuracy and precision, the problems are intra-examiner reproducibility and inter-examiner reproducibility. To improve intra-examiner reproducibility, examiners should be calibrated, and to improve inter-examiner reproducibility, examiners should be standardized.[15]

To date, intra-examiner calibration was performed by repeatedly measuring PD of a patient. Grossi et al.[13] set the goal of calibration as an intra-examiner reproducibility of 75% of measured sites with exact agreement, 95% within ± 1 mm, and no demonstrable examiner bias. Training was performed for 1–3 months and required recruitment of examinees. Calibration could be much easier using a model, since volunteers do not have to be recruited, and an examiner could be trained anywhere and anytime to the same standard.

If this model is to be used for calibration of clinical research, we need to perform training according to the method of Grossi et al.[11]

On the other hand, in the present study, the standard accuracy rate of Certified Periodontists was found to be 84.7% using the ROC curve to standardize examiners and to decrease inter-examiner errors. Thus, examiners who achieve an accuracy rate of 85% can be considered skilled examiners equivalent to Certified Periodontists. To draw ROC curves, data from the 1st measurement results of students were used as data of unskilled examiners, and data from the 4th measurement results of Certified Periodontists were used as data of skilled examiners. This is because examiners who could be considered as the most unskilled were students performing their 1st measurements, and examiners who could be considered as the most skilled among the participants were Certified Periodontists at their 4th measurements.

Some limitations of the present study should be noted. The model was designed to allow reaching the bottom of the pocket with adequate pressure. However, this model is unable to detect probing pressure. Examiners could, therefore, measure the PD correctly, even if they probed with too much pressure. A constant-force probe should be used to compensate for this. It could also be useful to give recognition for adequate pressure. If this model is to be used to calibrate examiners in clinical research, examiners should use a constant-force probe, which was proposed by Araujo et al.[1]

As reported previously, this model was useful for educational training.[14] Drucker et al. emphasized the importance of preclinical training to ensure accurate probing depths, but in conventional education, students do not have the opportunity to measure deep pockets before the clinical practicum.[16] Conventional dental models do not have the structure to simulate the bottom of periodontal pockets for pocket probe training. Moreover, in mutual training, most students are healthy, and thus, there was no chance to measure deep pockets. This model is effective in that students could be trained without patients, they can obtain feedback on the accuracy of measurements instantly, so that motivation to learn could be enhanced, and it could be used as an educational evaluation system because it provides objective data for evaluation.

Conclusion

Standardization of examiners on pocket probing could be carried out with the model. The standard accuracy rate equivalent to the skill of a Certified Periodontist was found to be 85%.

Conflicts of Interest

The model was jointly patented by Tokyo Medical and Dental University, Tokyo, Japan and Nissin Dental Products, Inc., Kyoto, Japan. One of the coauthors, Atsuhiro Kinoshita, is listed as a joint inventor on the patent. The other authors declared no conflicts of interest directly related to the content of this article.

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