International Journal of Oral Health Dentistry 2022;8(4):288–293

Content available at: https://www.ipinnovative.com/open-access-journals

International Journal of Oral Health Dentistry

Journal homepage: www.ijohd.org

Original Research Article

Self-assessment of hand instrumentation skills in pre-doctoral students using painted typodont teeth

Clara S. Kim[1,*], Josephine Franc[1], Ching-Hsiu K. Chiu[1], Sam Chui[1], Tobias K. Boehm[1]

[1]*Dept. of Periodontology, Western University of Health Sciences, Pomona, California, USA*

ARTICLE INFO

Article history:
Received 29-08-2022
Accepted 26-09-2022
Available online 19-12-2022

Keywords:
Clinical Education
Dental Hygiene
Education/Curriculum
Instrumentation
Periodontology

ABSTRACT

This study was conducted to determine if a hand instrumentation exercise on painted typodont teeth is a useful guided self-assessment tool for predoctoral students compared to artificial calculus on typodont teeth. Four (4) artificial calculus typodont teeth and four (4) painted typodont teeth were scaled by 69 fourth year dental students in fall of 2015 in their dental licensure board preparation course. Selected typodont teeth were free of calculus and instead painted. Students were asked to participate voluntarily in the survey for their perception of the new exercise and self-assessment of their hand instrumentation skill. The same set of survey questions were given after scaling artificial calculus and after painted teeth on mounted dental hygiene models on Simulation Manikins. Forty-four (44) students participated in the survey. The survey revealed that students felt significantly more familiar with overall hand instrumentation techniques after painted tooth exercise than calculus typodont teeth exercise. However, their responses showed statistically less confidence in their skill level in overlapping strokes, adequate force and correct finger grasp than traditional calculus typodont teeth. Students found the painted teeth exercise helpful in advancing their practical skills and spatial and anatomical arrangement ($p < 0.05$). For experienced predoctoral students, the painted typodont tooth exercise provided a more detailed, targeted self-assessment and better practical skill advancement than a traditional calculus typodont exercise.

1. Introduction

Dental typodonts have been used in preclinical dental education to mimic human dentoform in clinical settings since the late 1800's.[1] The main advantage of typodont is that students can practice technical skills safely without concerns for body fluid transmission, damaging tissues or harming patients.[2] It can be utilized to reinforce students' didactic learning including restorative, endodontic, and periodontal disciplines. When demand for a safe environment for learning and teaching is high, alternative use of a dental typodont in a simulated format is crucial.[3–5]

Typodont simulations have been found to be an efficient and effective transitional educational tool for students from pre-clinic to clinic.[6] Hand instrumentation techniques are introduced in pre-clinical periodontology courses on typodonts with Ivorene teeth and artificial calculus. Periodontal typodonts with artificial calculus teeth serve as challenging scaling and root planing cases, mimicking periodontally involved teeth and positions such as furcation or deep periodontal pockets that are hard to access. Students are instructed to practice removing calculus using several different skills: visual inspection, selection between various different types of instruments, adaptation, and strokes.[7]

* *Corresponding author*.
E-mail address: cskim@westernu.edu (C. S. Kim).

https://doi.org/10.18231/j.ijohd.2022.055

Manufactured artificial calculus can be a useful tool in simulating the texture and tactile sensation of larger calculus. However, one limitation is that the simulated subgingival calculus does not mimic physical properties of the natural substance.[8] As such, it can be visible under the simulated soft tissue (gingiva) and be taken off even without proper adaptation and force.

This study utilizes a new teaching exercise developed to encourage predoctoral dental students to visualize and assess their own instrumentation skills using painted typodont teeth. Students have to utilize adequate lateral force, as well as proper instrument angulation and adaptation in order to take thin paints off typodont teeth. Students can visualize and assess their own performance afterwards since instrument adaptation and strokes are clearly visible on the painted surface. We hypothesize that this new exercise provides guidance to students to recognize and improve their skills using visual acuity and self-assessment. Self-assessment requires reflecting on their own work and is essential for continuous learning and improvement of skills and knowledge.[9] It presents a "learning opportunity for students to build confidence, obtain experience and gain insight into the educational process without having negative consequences on the grade".[10] Although it is vital in students' learning, students are not familiar with performing and evaluating themselves accurately. Studies have reported overestimation of students' own ability during self-assessment and large discrepancy between faculty and students' assessment.[11] However, Tuncer et al. reported the discrepancy gets less with better self-insight as students advance in their training.[12] Also, other studies have found improvement in accuracy of self-assessment with multiple trials[13–17] which reiterates the importance of student learning experiences and practices.

The main objective of this pilot study was to examine if the painted typodont tooth (PTT) exercise improved operator confidence and technique familiarity compared to practice on teeth with artificial calculus (CTT) in preclinical dental students. We hypothesize that the PTT exercise provides educational benefit through improved visual feedback, allowing students improved self-assessment of hand instrumentation technical skills and performance.

2. Materials and Methods

This study was approved by the by the Institutional Review Board of the Western University of Health Sciences (approval # X17/IRB/015). 69 fourth-year dental students participated in a licensure board examination preparation course in the simulated clinic in five different sessions in September and October of 2015 at Western University of Health Sciences.

At the beginning of this trial, all students received a short in-person review on hand scaling. This included reminders on using short overlapping strokes, applying the lateral anterior 1/3 toe of the scalers with adequate lateral force and holding instruments with a tripod finger grasp. Students were informed of the goal and voluntary nature of the study. No compensation was offered to participate in the study.

Students scaled eight specific typodont teeth representing each sextant with commonly used periodontal instruments. These instruments included site-specific Gracey curettes (5/6, 7/8, 11/12, 13/14) and one sickle scaler (U-15 Towner/33 Jacquette, Hu-Friedy Mfg. Co., LLC Chicago, USA). Teeth to be scaled were selected based on the presence or absence of artificial calculus provided by the manufacturer (Nissin Dental Products, Inc. AB1-TRM.365.B1AN-TR.56C(31S) W/CAL).

Among the eight teeth each student scaled, four teeth had artificial calculus (1D, 20M, 16D, 22M), and four teeth (2D, 21M, 15D, 23M) were free of artificial calculus, but had their root surfaces painted with a black permanent marker (Sharpie®, Atlanta, GA) starting at the CEJ. The painted teeth were chosen to reflect similar dental anatomy and location of the calculus typodont teeth within the same dental sextants. They were mounted onto the dental typodont (Kilgore International®. Inc, Coldwater, MI) and the dental simulation manikin (A-dec®, Newberg, OR) prior to scaling any teeth.

We developed this study's questionnaire based on Barrero's questionnaire testing the educational benefit of different prosthodontic teaching techniques.[18] The questionnaire in this study consisted of ten statements. The first five questions asked for specific hand instrumentation skill sets and the question six to ten evaluated students' overall perceptions of the painted tooth exercise (Table I). The respondents indicated their agreement with each item, on a five-point Likert scale on which "strongly agree" carried 1, "agree" 2, "neutral" 3, "disagree" 4 and "strongly disagree" 5.

The questionnaire survey was administered twice; first after the students scaled traditional calculus teeth and visually evaluated their own work (CTT), and then after scaling painted typodont teeth (PTT, image 1). An audience response system allowed student participants to send in their results anonymously and electronically using a hand-held device. After students completed hand scaling on both sets of teeth and submitted their questionnaires, students had the opportunity to have questions answered and receive verbal feedback from supervising hygiene and periodontal faculty members.

The results were directly sent to the College of Dental Medicine, Office of Academic Affairs. Student responses were pooled into a group and anonymity of the data collected was assured. Data was tabulated using Excel(R) (Microsoft, Redmond, WA) and formatted for statistical analysis. Statistical analysis was performed using the R statistical package (Vienna, Austria). Differences in survey

response after the CTT and PTT exercise were assessed using the Wilcoxon signed-rank test. A p-value ≤.05 was considered statistically significant.

3. Results

Out of 69 fourth year dental students who participated in the licensure board preparation course, a range of 44 students participated and completed the questionnaires with a response rate of 64%. The two survey means and standard deviations for post-scaling calculus teeth and post-scaling painted teeth are calculated and listed in Table 1.

3.1. Hand instrumentation technical skills

Generally, students express higher familiarity and confidence after the PTT (Painted typodont teeth) exercise compared to the CTT (calculus typodont teeth). (Table 1). Student responses in regard to familiarity (Item 1) shifted significantly favorably for the PTT (PTT mean response 2.05 ± 0.60, CTT mean response 2.48 ± 0.64) towards "agree", with a high degree of consensus (few responses outside of "agree") and a marked reduction of "neutral" responses compared to the CTT (Figure 1). The CTT seems to build greater confidence as CTT responses trended more favorably in all confidence items (item 2 to 5), and there was a statistically significant shift in three of the four confidence items (Item 3 to 5) towards "agree"/" strongly agree" responses after the CTT compared to the PTT exercise. Students rated their skills critically and survey means were significantly higher after scaling PTT (Table 1). Within the PTT, the mean for holding correct grasp scored the highest mean of 3.73 ± 0.68, followed by short overlapping strokes (mean, 3.59 ± 0.78) and adapting anterior 1/3 toe (mean, 3.58 ± 0.75). Within the CTT, the highest mean was also found on holding correct modified pen grasp (mean, 3.42 ± 0.61), followed by adapting anterior 1/3 toe (mean, 3.38 ± 0.67) and overlapping strokes (mean, 3.19 ± 0.8).

3.2. Didactic benefit and motivation

Students generally agreed on the value and benefit of both exercises, with the most common response "agree" and a high level of consensus (item 6-10, Table 1). There was no statistically significant difference in response distributions between CTT or PTT exercise for most items (item 6-9), with students rating both activities highly in regard to stimulation, guidance, interest and promotion of additional learning. While students rated both activities highly for advancing anatomic and spatial skills, responses significantly shifted to "agree" for the PTT exercise (1.97 ± 0.71) compared to the CTT (2.25 ± 0.52) suggesting that the PTT exercise was more conducive for learning.

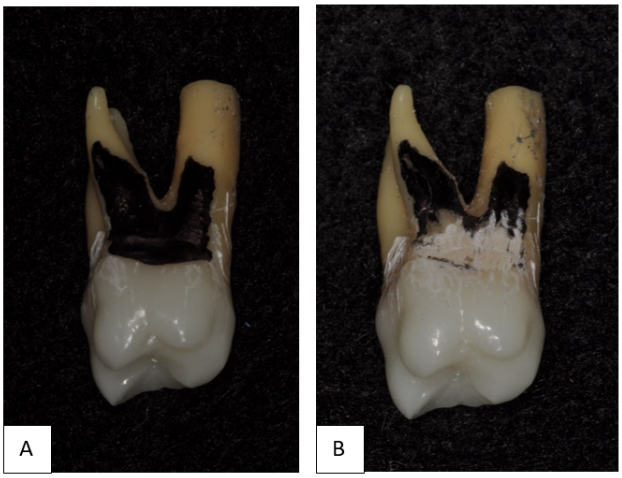

Fig. 1: Painted teeth **a**) Pre-scaling: smooth typodont tooth surface #15 distal was painted from CEJ to the level of artificial alveolus before installing in articulator **b**): Post scaling: scaler strokes are visible on the palatal root and remaining paints are noted under CEJ and at the line angle

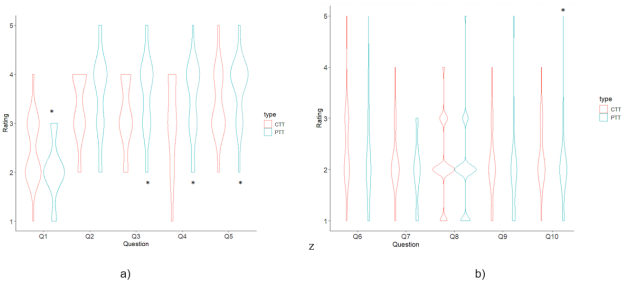

Fig. 2: Violin plot of student responses from 1-10. **a**): Statement one to five on the specific Hand Instrumentation Skill Set; **b**): Statement six to ten on didactic benefit and motivation. 1 = strongly agree, 2 = agree, 3 = neutral, 4 = disagree, 5 - strongly agree

4. Discussion

In this study we introduced the PTT (painted typodont tooth) exercise as an alternative to CTT (calculus typodont tooth) and demonstrated that both are perceived by students as useful activities to improve familiarity and confidence with hand scaling techniques. The PTT seems to be better at improving familiarity with hand scaling and enhancing anatomical and spatial skills whereas the CTT builds confidence in the technique.

The PTT exercise was developed with a goal of providing an additional practice for predoctoral students' self-assessment on technical periodontology courses. It parallels findings in the Best Evidence Medical Education (BEME) collaboration Systematic Review [19] that developing accurate self-assessment practice might be enhanced by "identifying previous subject knowledge or skill, providing some level of instruction about a skill, and utilizing video or verbal

Table 1: Dental students' overall perception and self-assessment of handInstrument skills as means and standard deviations for survey items 1-10

		Category and Item Description	Calculus Typodont Teeth (CTT)		Painted Typodont Teeth (PTT)	
			Mean	Standard Deviation	Mean	Standard Deviation
Hand instrumentation skills	1.	I am very familiar with the overall hand instrumentation techniques.	2.48	0.64	2.05*	0.6
	2.	I am confident in adapting anterior 1/3 toe of the scaler	3.38	0.67	3.58	0.75
	3.	I am confident in overlapping short strokes to remove all debris	3.19	0.7	3.59*	0.78
	4.	I am confident in applying adequate force to remove all debris	3.02	0.9	3.49*	0.75
	5.	I can competently hold the modified pen grasp with a stable fulcrum	3.42	0.61	3.73*	0.68
Didactic benefit & motivation	6.	This exercise provides high simulation and appropriate practice guidance for patient care	2.48	0.64	2.13	0.88
	7.	This exercise inspired me to master hand instrumentation knowledge and skills	3.38	0.67	1.95	0.65
	8.	This exercise was stimulating and interesting	3.19	0.7	1.98	0.8
	9.	This exercise gave targeted and objective recommendations on areas to improve	3.02	0.9	1.9	0.54
	10.	This exercise was helpful to advance our practical skills and spatial and anatomical arrangement	3.42	0.61	1.97 *	0.71

Each item was measured on a five level Likert scale. Positive responses were "strongly agree" (1 point) and "agree" (2 points), and negative responses were "neutral (3 points), "disagree" (4 points) and"strongly disagree" (5 points). * Statistically significance p-value< .05 (Wilcox test)

feedback associated with execution of a skill."[20] The PTT allows immediate visual feedback after the exercise as it clearly demonstrates instrument paths and clearly differentiates root surface areas where the student was successful in removing debris from those areas where scaling failed. This is reflected in the generally favorable student ratings on guidance and interest, and areas to improve. Therefore, it seems likely that the PTT aids self-assessment.

The difference in familiarity and confidence rating between both exercises is likely due to the different tactile nature of the painted surfaces versus surfaces covered with artificial calculus. The painted surfaces likely let students reliably and consistently feel root surface anatomy and provides easier insertion of instruments, thus providing familiarity with root surface anatomy and instrument insertion. In contrast to the permanent marker stain on root surfaces, artificial calculus provides tactile feedback and is easier to remove than the marker stain. Seeing and feeling calculus being removed, this likely creates greater confidence in students, albeit at the expense of familiarity.

Fourth year students at Western University of Health Sciences are offered courses in licensure board preparation in the early Fall. They have completed 10-15 quadrants of scaling and root planing in the clinic by the time they are in the periodontics course. Therefore, they tend to agree with the familiarity of the hand instrumentation and confidence level as shown by their response on statement one (Table 1). However, students' responses after PTT were significantly lower (mean 2.05) than CTT (mean 2.48). This is likely due to the order of introducing the scaling exercises - PTT was subsequently introduced after CTT and therefore students may have felt more confident after practicing consecutively. Additionally, students may gain more confidence in their hand instrumentation skills after students visualize their performance and self-identify the areas that they need to improve on the painted teeth. This latter explanation coincides with previous studies that found self-assessment presents with over estimation of confidence,[21] however, not necessarily correlated with

accuracy or objective external assessment results.[22]

In contrast, students' responses revealed different responses in analyzing deeper into specific aspects of their skills. Means for statements two to five had a range of 3.02-3.42 in calculus teeth, and the responses after painted teeth were higher (range: 3.59-3.79). Therefore, general responses on skills tend to be more disagreeing than agreeing with the statements showing less confidence regardless which type of typodont teeth were used. This shows students' response to being familiar with overall skill does not necessarily equate to their actual competency level: students may understand the didactic portion however lack the practice to adequately perform. Three out of four specific skills had significantly higher mean after scaling painted teeth than the calculus teeth: Utilizing overlapping short strokes (mean = 3.59), applying adequate force (mean=3.49) and holding correct finger grasp (mean = 3.73). Students were acutely aware of their deficiencies in hand instrument skills and were reflected in less confidence. The paint on the teeth cannot be easily removed without proper application of these specific hand skills. In addition, clearly visible strokes on painted surfaces may prompt the students to be able to evaluate their current skill level further critically. Adapting anterior 1/3 toe is the only skill that did not reveal a significant difference between two types of typodont teeth. It is the authors' opinion that adaptation of anterior 1/3 instrument is the hardest technical skill for students to practice since artificial calculus can be taken off with any part of the instrument. Also, on the painted teeth, stroke lines can be visible even if using incorrect parts of the instrument after scaling. Therefore, students did not find significant difference in confidence level on this skill after practicing on either type of typodont teeth.

Scaling painted teeth gives immediate visual evaluation of their hand instrumentation skill by seeing the removed paint and exposed typodont teeth surface. This is supported by students' responses to providing spatial and anatomical arrangement after scaling painted teeth. It was statistically different from the calculus teeth and had a low mean of 1.97. By visualizing presence or absence of stroke lines on the inaccessible anatomical areas, such as underneath cementoenamel junction and root concavity, students can focus on specific areas to analyze their work, improve, and apply for their future clinical care. All other statements showed equivalent responses from students showing the benefit of both types of typodont teeth. Although statistical significance was not achieved, the mean for the painted teeth generally showed lower numbers (range:1.90 - 2.13) than the artificial calculus teeth (range: 2.02 - 2.37).

A limitation of this study is that the educational validation of the painted teeth was not measured based on objective outcomes. This study was based on the perception of participating students. Although subsequent faculty assessment and immediate feedback was given during the course, it was not part of the study. Studies have found self-assessment alone is not a reliable measure of true clinical competence and skills.[19,22,23] Also studies,[6,10,12] have recommended utilizing peer assessment, faculty supervisory assessment, and objective measurement to reinforce the benefit and effectiveness of self-assessment. Deep et al. have found similarity between students' self-assessment grades and faculty grades and they attributed to the open feedback between faculty and students during the exercises.[10] Therefore including faculty feedback would have improved and strengthened this study.

Further, studies should combine self-assessment, peer assessment and faculty supervisory assessment to close the gap between perceived confidence levels and visual acuity in hand instrumentation scaling techniques. Study on other simulation methods on typodont teeth such as nail polish can be done to compare and find the best method in hand instrumentation course. The order of introducing CTT and PTT can be switched in the future crossover study as well. Utilizing the linear visual analog scale to rate students' pre- and post- familiarity and confidence level to find differentiation between both exercises can also be considered.

5. Conclusion

This study showed a positive response of students on the implementation of painted typodont teeth exercise for the predoctoral dental students in clinical periodontology courses. This exercise provides an immediate visual advantage in assessing their specific hand instrumentation skills. Students agreed that it provided equivalent practical guidance in hand instrumentation compared to using traditional artificial calculus typodont teeth and significantly more in giving spatial and anatomical arrangements. Students' summative perception and response on painted typodont teeth will benefit educators to use the new tool in addition to using a conventional way to teach hand instrumentation at a simulation clinic.

6. Source of Funding

None.

7. Conflict of Interest

The authors declare that there is no conflict of interest considering the design, execution, or presentation of the scholarly work and publication of this paper.

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Author biography

Clara S. Kim, DMD, MS

Josephine Franc, MSDH

Ching-Hsiu K. Chiu, DDS, MS

Sam Chui, DDS

Tobias K. Boehm, DDS, PhD

Cite this article: Kim CS, Franc J, Chiu CHK, Chui S, Boehm TK. Self-assessment of hand instrumentation skills in pre-doctoral students using painted typodont teeth. *Int J Oral Health Dent* 2022;8(4):288-293.