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Short Communication

Association of student performance between dental anatomy waxing and preclinical operative dentistry

Lang Liang [a†], Vivian Ha [a†], Amy Lin [a], Supattriya Chutinan [b], Hiroe Ohyama [b*]

[a] *Harvard School of Dental Medicine, Boston, MA, USA*
[b] *Department of Restorative Dentistry and Biomaterials Sciences, Harvard School of Dental Medicine, Boston, MA, USA*

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Abstract Spatial perception and psychomotor skills are critical components to clinical dentistry. However, measures within the dental school curricula have not been sufficiently studied and evaluated for their effectiveness in predicting preclinical performance. The objective of this study was to examine whether students' waxing skills are associated with preclinical operative performance. This study included 65 students from two class years at the Harvard School of Dental Medicine. Regression analysis was utilized to assess associations between waxing scores and operative exam scores. Waxing scores were found to be positively correlated with all operative practical exam scores and significantly associated with the class III resin composite restoration (coefficient, 0.42; $P = 0.02$) and the combined operative exam scores (coefficient, 0.33; $P = 0.04$). Wax-up assessments could serve as a predictor for preclinical performance and identify students who would benefit from additional assistance to help foster a more inclusive learning environment.
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* Corresponding author. Harvard School of Dental Medicine, 188 Longwood Ave, Boston, MA 02115 USA.
E-mail address: hiroe_ohyama@hsdm.harvard.edu (H. Ohyama).
† These authors contributed equally to this work and should be considered co-first authors.

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Introduction

Acquisition, evaluation, and development of psychomotor skills are imperative to dental education; proficiency in the preclinical setting is necessary prior to treating patients in the clinic. Preclinical exercises of note include teeth wax-up and operative assessments, such as preparation and restoration of plastic typodont teeth. Wax carving of teeth displays knowledge of dental anatomy acquired through didactic courses and must be accurate to natural morphology in order to restore proper spatial and functional components of human dentition. Of similar importance is the preclinical operative course, where students implement knowledge of dental anatomy, spatial assessment skills, and manual dexterity under faculty evaluation.

Previously, the perceptual ability test (PAT) of the Dental Admissions Test (DAT) was used as an assessment and predictor of spatial perception.[1] For more reliable predictors, some dental schools used wax carving and similar manual dexterity exercises as admissions criteria and have found them to be stronger predictors than standardized tests of student performance on practical examinations.[2–5] However, psychomotor assessment modality within dental school curricula has yet to be studied for better understanding of students' performance during their dental training.

It is important to find and utilize more reliable predictors of preclinical and even clinical performance to promptly provide students with additional enrichment, if needed. This study aims to investigate the association between preclinical student performance in dental anatomy waxing assessments, as indicated by faculty evaluation, compared to preclinical operative performance.

Materials and methods

The Harvard Longwood Medical Area Office of Human Research Administration (Boston, MA, USA) determined this study met the criteria for exemption according to regulations defined by the U.S. Department of Health and Human Services (IRB15-3845, MOD15-3845-5).

The study sample was a total of 65 students from two cohorts of predoctoral dental students (Class of 2021 and Class of 2022) at the Harvard School of Dental Medicine in Boston, MA, USA. As second-year students, they enrolled in an introductory dental course where they learned dental anatomy. With instructors' support, students completed formative wax-up exercises of the following permanent teeth: right maxillary central incisor, right maxillary canine, left maxillary first premolar, and left maxillary and left mandibular first molars. At the end of course, students completed a 4-h practical waxing assessment (right mandibular second premolar) without any help from an instructor or peer. The students' identifying information was blinded during the grading process in order to eliminate bias. The students' grades for this assessment were the average of the scores from the four faculty members who graded independently.

As third-year students, they participated in the preclinical operative course. They completed a series of nine formative exercises. These exercises included a diverse range of amalgam and resin composite procedures (preparations and restorations); Class I on the left maxillary and mandible first molars, Class II on the right maxillary and mandible premolars, Class III (only resin composite) on the right maxillary central incisor, Class IV (only resin composite) on the left maxillary central incisor, and Class V on the right mandible premolar and molar. Upon completing these exercises, the students were required to take preclinical practical exams. Passing these exams is necessary to advance to the core clinical experience with patients. There were four preclinical practical exam procedures: Class II amalgam preparation, Class II amalgam restoration, Class III resin composite preparation, and Class III resin composite restoration. The scores on these four procedures were also combined to create an overall operative exam score. All identifying information was blinded during the grading process. The students' grades for these exams were the average of the scores from three (Class of 2021) or two (Class of 2022) faculty members who graded independently. Two out of the three faculty members grading the Class of 2021 returned the following year to grade the class of 2022.

Average score intraclass correlation (ICC) was calculated using 1) absolute agreement and 2) consistency two-way mixed-effects model to measure interrater reliability, which were consistent with previous literature.[6–8] Regression analysis was used to assess trends and relationships between waxing assessment scores and operative exam scores. Statistical significance was defined as $P < 0.05$. All statistical analysis was performed using R software, version 4.1.2 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Coefficients, 95% confidence intervals (CI), adjusted R^2, and *P*-values from the regression analysis are shown in Table 1. Waxing assessment scores were found to be positively correlated with all operative preclinical exam scores,

Table 1 Regression analysis for correlation of waxing scores with operative exercise performance (N = 65).

Exercise	Coefficient (95% CI)	Adjusted R^2	*P*-value[†]
Class II amalgam preparation	0.31 (−0.17, 0.78)	0.01	0.20
Class II amalgam restoration	0.22 (−0.22, 0.66)	0.00	0.32
Class III resin composite preparation	0.34 (−0.08, 0.76)	0.03	0.11
Class III resin composite restoration	0.42 (0.06, 0.78)	0.06	0.02*
All operative exercises combined	0.33 (0.01, 0.64)	0.05	0.04*

[†]*$P < 0.05$.

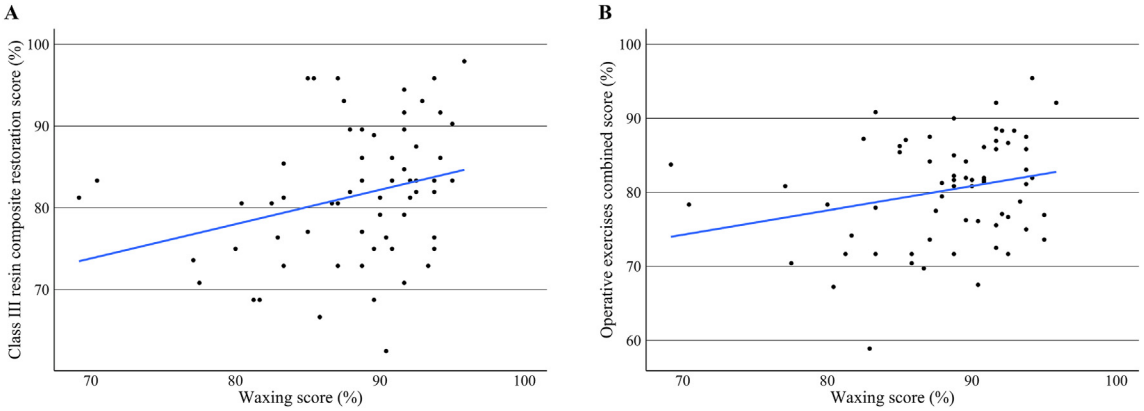

Figure 1 Relationship between waxing score and (A) class III resin composite restoration score and (B) operative exercises combined score (N = 65).

including the combined scores. Fig. 1 shows that the waxing assessment score was significantly associated with the class III resin composite restoration (coefficient, 0.42; 95% CI, 0.06–0.78; $R^2 = 0.06$; $P = 0.02$) and the combined operative exam score (coefficient, 0.33; 95% CI, 0.01–0.64; $R^2 = 0.05$; $P = 0.04$).

Discussion

Comparing dental anatomy waxing assessment scores to operative preclinical exam scores, our study found that students obtaining higher wax-up scores tend to have higher scores on all operative preclinical exams. Dental anatomy waxing assessment scores exhibit a positive association in all five domains – class II amalgam preparation, class II amalgam restoration, class III resin composite preparation, class III resin composite restoration, and the combined operative exam score. It was found that waxing assessment scores serve as a statistically significant predictor of class III resin composite restoration and all combined operative exam scores.

The perceptual ability test (PAT), wax carving, chalk carving, and other manual dexterity exercises have been used as admissions criteria and evaluated to predict preclinical performance in some dental schools. However, very little research data has used preclinical courses in the dental school curriculum to predict future performance. Wax-up exercises are completed in dental anatomy courses, one of the first clinical related courses completed in most dental schools. Given that our study has shown wax-up assessment scores to be promising predictors of preclinical operative performance, students' wax-up scores may serve as a reliable predictor of their future clinical performance. The need for a dependable predictor to anticipate preclinical performance will foster a more inclusive and supportive environment in which faculty can better identify students who may benefit from additional assistance earlier on. Supporting students prior to preclinical operative courses may correlate with improved clinical performance and patient outcomes.

A limitation of this study includes the small sample size, as the study was conducted across two classes at one institution. To further evaluate the validity of these results, data could be collected and evaluated from more classes to see if similar trends exist. Future studies that include other disciplines and dental institutions could be beneficial to expand the scope of the sampled population.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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