Relationship Between Hand-Skill Exercises and Other Admissions Criteria and Students' Performance in Dental School

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Abstract: The aim of this study was to investigate the existence of correlations between dental admissions criteria, including a chalk carving exercise, and students' subsequent academic performance. The retrospective cohort study examined the records of dental students at Louisiana State University Health Science Center School of Dentistry for the years 1998 to 2008. Only those students who could be categorized into the following four groups were included: 1) those who graduated in the top 10% of their class, 2) those who graduated in the bottom 10% of their class, 3) those who repeated a year of dental school, and 4) those who were dismissed or resigned. The study sample consisted of 176 students: 62 in the first group, 62 in the second group, 25 in the third group, and 27 in the fourth group. Data collected were each student's undergraduate grade point average (GPA); chalk carving score; undergraduate biology, chemistry, physics (BCP) GPA; Dental Admission Test (DAT) Academic Average; Perceptual Ability Test (PAT) score of the DAT; total DAT score; grade in preclinical operative dentistry class; grade in morphology and occlusion class; and dental school GPA at graduation. The results showed that only the undergraduate GPA and BCP GPA were significantly higher for students in the top 10% of their class than for other groups. The only positive correlation involving the chalk carving scores was with the preclinical operative dentistry course grade. This study thus found limited correlations between this institution’s admissions criteria and its students' success in dental school.

Keywords: dental education, dental school admissions, admissions criteria, chalk carving test

Submitted for publication 8/27/14; accepted 12/1/14

Which dental school applicants should we select? Which of the applicants are most likely to successfully complete dental school in the time allotted? These are just two of the questions dental school admissions committees must answer every year. With the application pool increasing by 50% over the last ten years, it has become a greater challenge to identify students who are most likely to succeed and graduate. Various admissions criteria are utilized and weighted differently depending on the individual dental school. The obvious question is: Are some of the criteria more predictive of success than others?

Previous studies have evaluated correlations between admissions criteria and dental school performance. The criteria used by many schools include undergraduate grade point average (GPA), undergraduate science GPA, Dental Admission Test (DAT) scores (both individual portions and total score), manual dexterity testing, and admissions interviews. These criteria, either all or in part, have been assessed for correlations with various performance measures such as dental school GPA, clinical and didactic grades, and National Board Dental Examination scores, and the degree of correlation observed between admissions criteria and performance measures varied greatly. Some studies have concluded that a combination of at least two admissions criteria is a more reliable way to predict success than any single criterion. Others have found the DAT Academic Average and undergraduate GPa to be two of the best predictors. A positive correlation has also been found between DAT science scores and undergraduate science GPA. A study by Sandow et al. utilizing a large number of students found that undergraduate science GPA consistently correlated with academic success in dental school.

As a profession, dentistry is seen as requiring skillful use of the hands, so it is not unreasonable to assume students selected for dental training would need to have developed such ability to complement their intellectual capacity. There is a long history of aptitude testing and dental student selection. Spratley's study about the appropriate criteria to use to choose from a pool of applicants yielded contradictory results. The DAT became required
of all applicants in 1951,\textsuperscript{12} and the chalk carving portion of the DAT was continued until 1972, when it was replaced by a written test to measure perceptual motor ability.\textsuperscript{13} Among the reasons given for the demise of the chalk carving portion of the DAT is the logistics of administering that portion of the exam to more than 15,000 students per year.\textsuperscript{13} Administering the chalk carving exam required a room with tables and resulted in chalk residue to be cleaned up and chalk carvings to be labeled, collected, and shipped intact to a central location for grading. Studies have reported conflicting results concerning the predictive value of the chalk carving test.\textsuperscript{11-15} Peterson explained that “the purpose of the Chalk Carving Test was never to predict the grades that the dental student might expect to receive in his technic courses. Its purpose was certainly not to predict how well a student would perform in theory and didactic courses. The Chalk Carving Test had a very simple and very important objective: to enable admission committees to keep a student ‘with five thumbs’ out of dental school and to save that place for a more worthy applicant.”\textsuperscript{16}

In addition to utilizing many of the above mentioned criteria, Louisiana State University Health Science Center (LSUHSC) School of Dentistry requires applicants at their interview to carve a piece of chalk. This exercise is similar to the prior chalk carving portion of the DAT. The applicant is provided with a single piece of chalk, ruler, knife, pencil, written instructions, and diagrammed dimensions and is given 35 minutes to carve the prescribed shape and dimen-

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**Chalk Carving Test Measurements**

A. Chalk

B. Top View

C. Side View

D. Bottom View

E. Perspective from side and rear

F. Perspective from front and side

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Figure 1. Chalk carving test used as one criterion for admission
sions (Figure 1). The applicant’s carving is graded on a scale of 0 to 10 by the director of admissions. Carvings are scored for smoothness of surfaces, sharpness of angles, symmetry of the finished product, and accuracy of reproduction (i.e., measurements). The scores from all four areas are totaled and averaged for the final score, which is reported to the admissions committee for consideration when discussing the applicant’s interview. This school’s admissions committee has subjectively felt that this exercise is beneficial in assessing applicants’ ability for spatial visualization and ability to work with their hands. The aim of this study was to investigate correlations between applicants’ chalk carving scores and other admissions criteria with their successful completion of the dental school curriculum, their ranking at graduation, and the grades they obtained in two first-year classes requiring hand skills.

## Materials and Methods

Approval for this study was given by the LSUHSC Institutional Review Board. The retrospective cohort study examined the records of dental students at LSUHSC School of Dentistry for the years 1998 to 2008. Only those students who could be categorized into one of the following four groups were included: 1) those who graduated in the top 10% of their class, 2) those who graduated in the bottom 10% of their class, 3) those who repeated a year of dental school, and 4) those who were dismissed or resigned. The following information was collected for each student: undergraduate GPA; chalk score (graded by the same person for the study period); undergraduate biology, chemistry, physics (BCP) GPA; DAT Academic Average (AA); Perceptual Ability Test (PAT) score of the DAT; total DAT score (TDAT); grade in preclinical operative dentistry class; grade in morphology and occlusion class; and dental school GPA at graduation. The admissions data were obtained from the university’s Office of Admissions, and dental school grade information was obtained from the Office of Academic Affairs.

Analysis of variance (ANOVA) was used to compare the four groups in terms of GPA, chalk scores, and standardized test scores with Tukey’s honestly significant differences test used for post hoc analysis. The Kruskal-Wallis test was used to compare groups for individual course grades. Pearson’s correlation coefficient (PCC) was used to examine correlations among standardized test scores, GPA, and chalk scores. A multiple linear regression model was fit to examine the ability of admissions criteria to predict dental school GPA. SAS version 9.3 (SAS Institute Inc., Cary, NC, USA) was used for all data analysis.

## Results

The records of 176 students were included in the study. The number and percentage of students in each academic performance category were as follows: top 10%: n=62 (35.2%); bottom 10%: n=62 (35.2%); repeated: n=25 (14.2%); and dismissed: n=27 (15.3%). Characteristics of these 176 students are summarized in Table 1. These students’ mean undergraduate GPA upon applying to dental school was significantly higher for students in the top 10% of their class than...
for students in the bottom 10% (p<0.001), students who repeated (p=0.021), and students who were dismissed (p=0.002). Similarly, the mean BCP GPA was significantly higher for students in the top 10% of their class than for students in the bottom 10% (p<0.001), students who repeated (p<0.001), and students who were dismissed (p=0.026).

The students’ undergraduate GPA (r=0.549, p<0.001), BCP GPA (r=0.577, p<0.001), DAT AA (r=0.237, p=0.010), and TDAT (r=0.215, p=0.020) all showed a significant positive correlation with their dental school GPA. The undergraduate GPA of these students showed a significant positive correlation with BCP GPA (r=0.891, p<0.001), DAT AA (r=0.362, p<0.001), and TDAT (r=0.363, p<0.001), but a significant negative correlation with PAT (r=0.159, p=0.042). BCP GPA was also negatively correlated with PAT (r=0.167, p=0.031). DAT AA was positively correlated with TDAT (r=0.869, p<0.001) and BCP GPA (r=0.343, p<0.001). The chalk carving scores showed a significant positive correlation only with the preclinical operative dentistry course grade (r=0.249, p=0.002). When a multiple linear regression model was fit, although statistically significant (p<0.001), only 36% of the variation in dental school GPA was explained by all of the admissions criteria combined.

Discussion

With a large number of applicants competing for a limited number of positions in U.S. dental schools, admissions committees face the difficult task of deciding which applicants to select. The selection of applicants who will most likely complete the dental school curriculum in the allotted time is of utmost importance. Students whose academic performance is not sufficient to pass a course or multiple courses will have to repeat the course(s) and may even be required to repeat the entire academic year, sit out an academic year, or could potentially be dismissed from the school. Such occurrences cause waste for the dental school in terms of staffing and resources devoted to students who do not perform well. The students themselves suffer from financial obligations, wasted time and energy, and psychological stress and some degree of social stigmatization.

Since dentistry is a profession requiring not only didactic knowledge but manual dexterity, it is logical that students selected for this profession should possess both attributes. Assessing didactic aptitude is easier for admissions committees due to the number of assessment measures available such as DAT scores, undergraduate GPA, etc.; but manual dexterity is more difficult to measure. Technological developments may help solve this problem. Computer-assisted simulation training and haptic simulators have shown some positive correlation with preclinical performance in limited studies.17-21

The dental school in our study has been using essentially the same admissions criteria for more than 30 years, but it has not examined the extent to which these criteria predict who will be a successful dental student. Specifically, the chalk carving test, which has been used since 1985, has not been critically evaluated for its effectiveness in helping to select the applicants most likely to successfully complete the curriculum. This dental school had a dismissal rate of 4.5% over the period studied, in contrast to the national attrition rate, which reached a high of 3% in 2000-01 and was down to 1.9% in 2009-10.22 (The numbers of our students dismissed by reason for 1998 to 2008 are shown in Table 2.) This higher than national average dismissal rate dictates the need for the school to critically evaluate its student selection criteria.

In this study, the chalk scores of the four groups were not significantly different. The only positive correlation involving chalk scores was with the preclinical operative dentistry course grade, but chalk scores showed a significant negative association with DAT scores. The observed positive correlation with preclinical operative dentistry course grade is in agreement with other studies that have found the chalk carving test to be predictive of students’ performance in courses requiring hand skills.23-25 Our study also found no significant difference in mean PAT scores among the four groups. However, the PAT scores did show a negative correlation with GPA and BCP GPA. These findings would suggest that the strong emphasis placed on an applicant’s ability to demonstrate perceptual ability or hand skills prior

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to dental school is unfounded. Perhaps students are able to develop sufficient manual dexterity while in dental school.

This study found that the students who finished in the top 10% of their class had significantly higher undergraduate GPAs compared to students who finished in the bottom 10% of their class, repeated one or more years, or were dismissed. This finding is in agreement with other published studies concerning admissions criteria and academic performance.\(^2,5,25,26\) A significant positive correlation was also observed between dental school GPA and BCP GPA as well as DAT AA and TDAT, which is also in agreement with previous research.\(^2,5\)

We found a significant difference among the four groups’ mean undergraduate BCP GPA, which was significantly higher for students in the top 10% of the class. Interestingly, the BCP GPA was significantly higher for dismissed students than for those who repeated or were in the bottom 10% of their class. Dismissed students also showed a marginally higher (although not statistically significant) TDAT and DAT AA than those students in the bottom 10% of the class. While the dismissal rate was 1.6% for academic reasons, the mean BCP GPA of 3.4, TDAT of 19.1, and DAT AA of 19.3 of these students suggests adequate intellectual ability, so perhaps there were other factors that affected the students’ ability to adequately perform. Privacy regulations prevent investigation of factors such as physical or mental issues, financial pressures, family pressures, or addiction. It is not unlikely that such issues could result in an otherwise intellectually capable individual performing below acceptable levels in dental school.

While many schools have similar admissions criteria, there is variability in the criteria used and certainly in the weight given to the various criteria. Our study and a previous study evaluated numerous indicators of dental school performance.\(^27\) It is important for admissions committees to be aware of the usefulness of the criteria being employed in order to select students who are likely to succeed at their institution.

Regarding interpretation of the results observed in our study, although statistically significant, the small to medium magnitude of the effect sizes of some of the bivariate correlations suggest that many relevant factors are not captured in the data. In fact, most of the variation (64%) in dental school GPA was not explained by the school’s admissions criteria. One could speculate that factors related to students’ personalities, life events, etc. also have a major impact on their academic performance. Although data were not captured for factors such as these, we have identified some important factors that may explain a significant proportion of the variation in academic performance in dental school.

This study had some possible limitations. Since the chalk carving exercise and other admissions criteria are used to screen for admission, the sample does not include those applicants with the lowest scores who were not admitted, thereby restricting the range of scores. This range restriction affects the correlation coefficients between predictors and outcome variables, causing them to be lower for students than would have been the case if the entire pool had been admitted.\(^28-30\) In addition, the study was an observational study, which limits the ability to make inferences with regard to causal relationships. Other limitations are that the rare use of the chalk carving test by other dental schools does not allow for comparison of the data, and this study was conducted at a single institution, which limits generalizability.

### Conclusion

This study found limited correlations between this dental school’s admissions criteria and its students’ subsequent success in completing the curriculum. Unlike admissions committees at all dental schools, our admissions committee needs to critically evaluate the criteria being utilized in order to optimize the selection of applicants who are most likely to successfully complete their dental education.

### REFERENCES