ORIGINAL RESEARCH

A Survey of US Air Force General Dentists Regarding Computer-aided Design/Computer-aided Manufacturing Usage

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Abstract

Aim: The purpose of this study was to survey all United States Air Force (USAF) general dentists regarding their experience with computer-aided design/computer-aided manufacturing (CAD/CAM) while in a dental school. Dental school graduation year and location was compared to the type and amount of CAD/CAM training and clinical experience during dental school to better understand the differences and influence of this technology.

Materials and methods: A survey consisting of six questions was sent through e-mail to 546 general dentists in the AF Dental Corps in 2018 of which 306 replied (56% response rate).

Results: Dentists who graduated in 2005 or earlier and between 2006 and 2009 stated they did not receive CAD/CAM training in dental school, while more respondents in the group of graduation years 2014–2017 stated that they did receive training. About 11% of the respondents who graduated in 2014–2017 completed 6–10 restorations and 9% completed 11 or more restorations compared to the other year groups. More respondents who graduated from a dental school in the southwest and southeast regions of the United States reported completing more restorations compared to other school regions.

Conclusion: Computer-aided design/computer-aided manufacturing is now becoming a prevalent curriculum in US dental schools, both as a core requirement and an elective. Its training platforms varied from lectures and literature reviews to preclinical laboratory.

Clinical significance: More respondents in the groups of graduation years 2014–2017 had completed more CAD/CAM restorations compared to other year groups; however, most of the respondents did not feel their training was sufficient enough to use CAD/CAM technology independently.

Keywords: Computer-aided design/computer-aided manufacturing training, Dental school, General dentists, Survey.

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Introduction

The first computer-aided design/computer-aided manufacturing (CAD/CAM) restoration was placed in September 1985 at the University of Zurich Dental School.[1] At the time, it was a revolutionary concept for restorative dentistry that an industrially made ceramic material could be fabricated through using the CAD/CAM technology that scans a tooth preparation, designs the crown, and then mills the final proposal. This technological advancement has increased clinical effectiveness, eliminating certain procedures and reducing two dental appointments to a single visit.[2] Also, the ability to store and send impressions digitally has significantly improved clinical efficiency and workflow.[1] With dental CAD/CAM technology becoming increasingly popular due to its accuracy and excellent esthetics and its savings on time and material,[3,4] many dental schools across the United States have stared incorporating the use of the CAD/CAM technology in their training programs and clinics.[5]

Even though CAD/CAM technology ushers in radical changes in restorative treatment, there are currently no published data that survey the amount and type of dentists' CAD/CAM trainings and the number of CAD/CAM restorations placed while in a dental school. Recognition of the disparity in dentists' exposures and experiences in the CAD/CAM technology are key in dental curriculum development and training improvement and in maintaining common core standards. One published study did examine the integration of the CAD/CAM technology in the United Kingdom and found that 64.4% of the dentists responding to the survey indicated they use the CAD/CAM technology to improve the quality of their workflow. However, this same study also found that 33.9% respondents felt their CAD/CAM training was insufficient.[6] The United States Air Force (USAF) Dental Corps recruits approximately 60–80 dental graduates each year from various dental schools throughout the United States. The CAD/CAM training received may not be standardized or consistent at the different dental schools.[3] The purpose of this study was to survey incoming dental officers

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from different dental school graduation years to understand the trends over time regarding the type of CAD/CAM training and total number of restorations placed while in a dental school.

Materials and Methods

The Institutional Review Board at Wilford Hall Ambulatory Surgical Center approved the human exempt protocol #FWH 20180093E. A survey was generated, consisting of six questions (Table 1), which were electronically distributed to 546 general dentists in the AF Dental Corp using the website "Survey Monkey." Before taking the survey, the respondent was reminded with a statement, stating the purpose of the survey and that anonymity would be preserved. Questions were multiple-choice, closed-ended questions, but an option was offered for further comments at the end. The survey was made available for 2 months, spanning from August 1, 2018, to September 30, 2018, during which three reminders were sent out.

The survey consisted of two sections: demographics and dental school CAD/CAM training. The responses were analyzed using Excel (Microsoft, Redmond WA) and the SPSS (Version 24, IBM, Armonk, NY) software. Survey respondents were placed in one of four groups, representing their year of graduation from a dental school: group I was 2005 or earlier; group II was 2006–2009; group III was 2010–2013; and group IV was 2014–2017. Respondents were also placed in one of five regions, pertaining to the location of their dental school in the United States:[7] west, southwest, Midwest, southeast, or northeast.

The questions and responses regarding demographics and CAD/CAM training in a dental school were statistically analyzed using the Chi-square test to determine statistical significance ($\alpha = 0.05$).

Table 1: Survey questions (with responses results)

1. Are you male or female?
   - ☐ Male (72.7%)
   - ☐ Female (27.3%)
2. How many years have you been active duty AF?
   - ☐ 1–4 years (45.1%)
   - ☐ 5–8 years (19.7%)
   - ☐ 9–12 years (14.5%)
   - ☐ 13–16 years (8.9%)
   - ☐ 17–20 years (2.6%)
   - ☐ 21+ years (9.2%)
3. Did you receive any CAD/CAM training in a dental school?
   - ☐ Yes (47.4%)
   - ☐ No (52.6%)
4. Which type of CAD/CAM training did you receive in a dental school?

   See detailed results in Table 2
   - ☐ Lecture
   - ☐ Literature review
   - ☐ Elective
   - ☐ Preclinic (dentoform)
   - ☐ Online CE
   - ☐ CE course (outside of school)
   - ☐ Assisted/observed in clinic
   - ☐ Manufacturer training
5. Do you feel your dental school CAD/CAM training was sufficient to operate the CEREC chairside unit independently?
   - ☐ Yes (24.0%)
   - ☐ No (76.0%)
6. In your dental school clinic, how many CAD/CAM restorations did you complete?
   - ☐ 0 (52.6%)
   - ☐ 1–2 (22.5%)
   - ☐ 3–5 (12.6%)
   - ☐ 6–10 (6.1%)
   - ☐ 11 or more (6.1%)

Results

The total number of completed surveys was 306, which yielded a response rate of 56%. The majority of the respondents were male (72.7%) vs female (27.3%) ($n = 300$). The gender of the respondents was compared to the four graduation year groups. Overall, there was a significant association between gender and graduation year groups ($p = 0.0009$). More males were in the group of graduation years 2005 or earlier, while more females were in the group of graduation years 2010–2013. There were no associations between gender and dental group regions ($p = 0.42$).

When asked if respondents had any type of CAD/CAM training in a dental school, 47.4% indicated that they did while 52.6% reportedly did not receive any training ($n = 291$). These numbers were compared to their year of graduation and regional location of their dental school. Overall, there was a significant association between CAD/CAM training and graduation year groups ($p < 0.0001$). About 94% of the respondents in the group of graduation years 2005 or earlier as well as 88% of the 2006–2009 group stated that they did not receive training in a dental school, while 76% of the respondents in the group of graduation years 2014–2017 stated that they did receive training. There was no statistical significance found relating CAD/CAM training with the dental school region ($p = 0.608$).

Respondents were asked what type of CAD/CAM training they participated while in a dental school (Table 2). This included lecture, literature review, elective, preclinic (dentoform), online continuing

Table 2: Type of computer-aided design/computer-aided manufacturing training compared to the graduation year group. The numeric value indicates percentage of dentists in the graduation year group (column) who received that respective type of training (row)

	2005 or earlier	*2006–2009*	*2010–2013*	*2014–2017*
Lecture*	33.3	58.3	76.5	93.6
Literature review*	11.8	30.0	30.0	64.0
Elective*	5.9	12.5	33.3	50.7
Preclinic (dentoform)*	0	12.5	52	84.5
Online CE	5.9	0	0	19.7
CE course (outside of school)	5.9	30.0	15.0	28.2
Assisted/observed in clinic*	10.5	20.0	52.2	74.7
Manufacturer training	11.1	22.2	21.1	37.8

*Indicates significant data

education (CE), CE course (outside of school), assisted/observed in clinic, and manufacturer training ($n = 188$). The graduation year group was associated with lecture ($p < 0.0001$), literature review ($p < 0.0001$), elective ($p = 0.002$), assisted/observed in clinic ($p < 0.0001$), and preclinic ($p < 0.0001$) but not with online CE ($p = 0.07$), CE course ($p = 0.18$), and manufacturer training ($p = 0.10$). None of the trainings were associated with the dental school region ($p = 0.15$).

When asked if respondents felt that their dental school CAD/CAM training was sufficient to operate the Chairside Economic Restorations of Esthetic Ceramics (CEREC) chairside unit independently, the majority (76%) felt they were not proficient compared to 24%, who felt like they were sufficiently trained ($n = 192$). The graduation year group was statistically associated with the perception of sufficient training ($p = 0.0005$) but not with the dental school region ($p = 0.31$). About 34% of the respondents in the groups of graduation years 2014–2017 stated that they were sufficiently trained compared to other year groups.

In regards to the amount of CAD/CAM restorations completed in dental school, more than half of the respondents (52.5%) stated that they did not complete any restorations and nearly a quarter (22.5%) only completed one or two. The graduation year group was statistically associated with the number of CAD/CAM restorations completed in a dental school ($p < 0.0001$) and also with the dental school region ($p = 0.036$). About 11% of the respondents in the graduation year group 2014–2017 completed 6–10 restorations and 9% completed 11 or more restorations compared to the other year groups. About 15% of the respondents from dental schools located in the southwest indicated they completed 6–10 restorations as well as 15% indicated they completed 11 or more restorations compared to other school region groups. Additionally, 12% of the respondents from dental schools in the southeast indicated they completed 6–10 restorations and 10% indicated they completed 11 or more CAD/CAM restorations compared to other regions.

Discussion

Survey Design

A total of 306 responses yielded a response rate of 56%. Typically, a response rate of an online survey ranges from 20–30%.[8] A response rate of 56% in this study permits some meaningful conclusions within the population of general dentists in the USAF. A number of factors could have influenced the response rate: all e-mails addresses were validated through the USAF, multiple reminders were sent out to both dental leadership to all 74 dental clinics, and reminders with the link to the survey embedded in a monthly newsletter were sent out by the AF Medical Operations Agency. Surveys were not sent to specialists to maximize the amount of response from dentists who utilized the CAD/CAM technology.

Demographics

The majority of the dentists who completed the survey had 1–4 years of experience as a dentist in the AF (Table 1). Many dental officers separate from the military service at 3–4 years after fulfilment of their initial service obligation. Respondents in the 1–4 year group represent younger dentists who are more likely to use the CAD/CAM technology in AF dental clinics.

Responses from CAD/CAM Users

Just less than half (47.4%) of the respondents indicated that they received CAD/CAM training while in a dental school. Dentists, who had recently graduated from a dental school in the 2014–2017 year group reported they received some type of CAD/CAM training in a dental school. However dental school graduates of 2005 or earlier were less likely to use CAD/CAM. Several studies have been published evaluating the incorporation of the CAD/CAM technology into the preclinical and clinical curriculum.[3,9–13] The studies reported a positive attitude of the students toward the technology but also noted that they felt insufficiently informed and expressed the need for additional education. In a recent 2019 study by Zimmermann et al., fourth-year dental students were introduced to the CAD/CAM technology and their clinical experience was accessed with a questionnaire.[13] During a 5-month course, students completed conventional and CAD/CAM all-ceramic restorations. About 95% of the students requested that the technology be introduced into the curriculum.[13] A 2015 survey found that 76% of the dental schools in the United States have at least one and many have 10 CAD/CAM units.[5] Based on these trends, it appears that US dental schools are starting to ramp up their focus on CAD/CAM in their curriculum to adjust to the real-world demands of same-day crown delivery. A 2016 survey by Tran et al. found that many practicing dentists in the United Kingdom did not receive CAD/CAM training in a dental school. Reportedly, most only received training from companies or were self-taught, clearly highlighting the need for education and training in dental schools.[6] In addition, CAD/CAM systems are very expensive and there is a need for experienced dental office staff who are able to handle these systems.[13]

Regarding the type of CAD/CAM training that the respondents received while in a dental school reported in this study, there were significant correlations between the younger graduation (2014–2017) year groups related to lecture, literature review, elective course, and preclinic (dentoform)—however not with online continuing education, CE course, or manufacturer training. From this data, we can gather that dental schools are using mainly lecture, articles, courses, and preclinical courses to teach their dental students about CAD/CAM. Most dental students are likely getting their information about CAD/CAM in their dental school curriculum and not seeking or paying for additional continuing education from online continuing education courses. As shown in Table 2, lecture was the highest percentage across year groups relative to other learning modalities. Also when examining year groups from 2005 or earlier to 2014–2017, there was generally an increase in literature review, CAD/CAM electives, training on preclinic dentoform, assisting/observing in clinic, and participating in manufacturer training. These data suggest that dental schools over the course of time have increased the availability for their students to learn about CAD/CAM.

Even though CAD/CAM training is starting to become integrated in most dental school curriculums, only 34% of respondents who graduated from 2014 to 2017 felt like their training was sufficient to operate the CAD/CAM chairside unit independently. Perhaps this is due to the dentist playing a more active role in the digital laboratory aspect of dentistry instead of making traditional impressions and sending it to the lab. Once the preparation is scanned, the provider can virtually manipulate the proposed restoration using digital techniques, putting the laboratory effort into the dentist's hands. In the process of designing a restoration, there is a learning curve involved to ultimately feel comfortable scanning clinically, and navigating the software. This survey data also supported continued CAD/CAM training after a dental school. In the USAF, the majority of dentists attend a 1-year advanced education in the general dentistry program where they receive additional training on the CAD/CAM technology from dental staff with advanced training.

As expected, more graduates from years 2014–2017 completed between 6–10 restorations and 11 or more restorations compared to other groups. This data suggest that dental schools are not merely trying to give their students a one-time experience with CAD/CAM but rather exposing them to multiple opportunities to utilize CAD/CAM clinically. There was also a correlation between the amount of restorations and respondents who graduated from schools in the southwest and southeast regions of the United States. This finding could be a result of the management and recruitment of patients in dental schools within these two regions to ensure there is no shortage of clinical cases. Further investigation is required in this area to understand the connection between the amount of CAD/CAM restorations completed and the region of the United States.

Conclusion

Within the limits of this study, the following conclusions could be drawn. Computer-aided design/computer-aided manufacturing is becoming a more prevalent part of the dental school curriculum, which is mainly utilizing lectures, literature reviews, elective courses, and exposure preclinically for training. Most of the respondents did not feel their training was sufficient enough to use the CAD/CAM technology independently. More respondents in the groups of graduation years 2014–2017 had completed more CAD/CAM restorations compared to the other year groups.

Disclaimer

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