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Effectiveness of digital visualization in teaching crown preparation to predoctoral dental students – A Pilot study

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ABSTRACT

Background: Virtual simulation via haptic feedback could be a good approach to get a lot of preclinical experience for dental students in a fast and efficient way. This study aimed to evaluate and compare the crown preparation by third year dental students via virtual reality and the same done in a conventional training environment on typodont teeth.

Materials and methods: 24 second-year dental students of the Saveetha Dental College and Hospitals, Chennai were enrolled and randomly defined. Group A (n=12) included crown preparations on Virteasy haptic simulator, and group B (n=12) included conventional crown preparation on typodont teeth (Nissin Dental Products, India). The students performed four crown preparations and each crown preparation was graded by the same teacher. Statistical analysis was done using independent t-test.

Result: The 1st tooth preparation of both the groups showed no statistical difference ($p>.05$), but all the subsequent tooth preparations of Group B were significantly better ($p<.05$) than those of Group A.

Conclusion: Haptic simulation is an effective tool in teaching crown preparation to pre doctoral dental students and can provide better training as compared to conventional crown preparation on typodont teeth.

Keywords: *Dental, haptic simulation, tooth preparation, training*

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INTRODUCTION

Dental students spend years honing psychomotor skills in order to be ready for entry-level clinical practice. Under the guidance of dental specialists, they practise on artificial or extracted teeth attached to a dental phantom head or to real patients to hone their dental skills. Their training outcomes are subjectively assessed by the dental specialists. This method has drawbacks, including a dearth of challenging real-world situations, a shortage of professional supervision, and the arbitrary nature of surgical skill evaluation. With the advancement of virtual reality (VR) technology, VR simulations are becoming more common.(1–3). The benefits of these simulators include the ability for trainees to perform treatments anywhere at no additional cost and the ability to produce any type of dental surgical scenario. The use of haptic devices that provide users with a tactile feel has greatly improved the realism of dental simulators. (4–6).

Virtual simulation or computer-assisted virtual assistance could be a good approach to get a lot of experience in a short amount of time. Towers et al. discovered in a review of the literature in 2019 that many issues remain about the application of haptic simulation in dentistry, notably about what functions and places it should be given in dental education programmes.(7) Virtual reality paired with instructor feedback helps in grasping basic skills in conservative dentistry.(1) According to Wang et al 2015, Potential advantages of virtual reality systems over traditional Phantom head need further exploration. Students can repeat operations an endless number of times using the rapidly evolving haptic simulators combined with virtual reality. Suebnukarn et al. described the cost benefits of not having a repeat restriction.(8,9) Furthermore, haptic simulation may be an environmental improvement because it reduces the trash generated by previous simulation systems that use plastic teeth. As part of continuous professional development, virtual reality could be utilised to certify practitioners' clinical capabilities. Simulation in dentistry has demonstrated greater efficacy in teaching than traditional methodologies since its debut, owing to more effective learning and consistent feedback.(10,11) I has shown promising results in a variety of fields in dentistry like implantology,(12–14) oral surgery,(15,16) prosthetics,(17,18) pediatrics,(8,19) radiology,(20,21) conservation dentistry,(Eve EJ et al 2014) and endodontics(8).

To the best of the authors' knowledge, no study has been done comparing crown preparation via virtual reality and conventional methods in the Indian population. This study aimed to evaluate and compare the crown preparation by third year dental students via virtual reality and the same done in the conventional analogic training environment. The null hypothesis was that there would be no significant difference between the crown preparations done by the two methods.

MATERIALS AND METHODS

As per the procedures of Saveetha Institute of Medical & Technical Sciences, this study was submitted to the Research Department and the Ethics Committee of the Saveetha Dental College and Hospitals, Chennai. The study was conducted at Saveetha Dental College and Hospitals, Chennai in early 2021. 24 second-year dental students of Saveetha Dental College and Hospitals were enrolled and randomly defined. Group A (n=12) included crown preparations on a haptic simulator (Virteasy; HRV Simulation, France), and group B (n=12) included conventional crown preparation on typodont teeth (Nissin Dental Products, India). The students performed four crown preparations: Prep1- Maxillary central incisor, Prep 2- Maxillary canine Prep 3- Maxillary first premolar Prep 4- Maxillary first molar. Each of these tooth preparations were graded by the same teacher. For both groups, the time limit for each cavity preparation was one and a half hour. These sessions were conducted once a week.

Crown preparation on Virteasy

The Virteasy haptic simulator works on a Windows personal computer. The simulator software can be used with the touch screen control. 3D view is provided by 3D stereoscopic glasses (Estar America ESG6100, USA). A plastic contra-angled handpiece is connected to force feedback arm device (Haptic Device with

Geomagic Touch, Geomagic Inc., USA) to transact the tactile sensations of crown preparation with a bur on the tooth. The virtual handpiece is started by a foot pedal. The students had not been exposed to any dental virtual simulation software before the commencement of this study.

Prior to starting, all students received a brief introduction to using the simulator, which covered using the virtual handpiece, adopting correct body posture, and using the machine's feedback force. The same teacher rated each student's crown preparation following every crown preparation activity on the haptic simulator.

Crown preparation on typodont teeth

Just like in haptic simulator exercise, the students in this group had not performed crown preparation before and were given a short demonstration of the same before the exercise. Each student was graded for four of their crown preparations after each session by the same teacher.

Statistical analysis

Independent t-test was performed for statistical analysis using SPSS v23.0 (IBM, USA). A probability $p<0.05$ was considered significant.

RESULTS

Independent t- test was performed to compare the grades of both the groups. There was no significant difference ($p>.05$) in the 1st tooth preparation of both the groups, but all the subsequent tooth preparations of Group B were significantly better ($p<.05$) than those of Group A.

TABLE 1: Table showing mean grades of BDS students in Group A and Group B for four different crown preparations.

	Year	Grade	Std. Deviation	Std. Error Mean
Prep 1	Group A	66.3333	7.84316	2.26413
	Group B	70.4167	4.98102	1.43790
Prep 2	Group A	64.3333	6.31497	1.82297
	Group B	72.0833	6.55686	1.89280
Prep 3	Group A	58.1667	25.15708	7.26222
	Group B	80.4167	9.64326	2.78377
Prep 4	Group A	55.2500	5.73863	1.65660
	Group B	78.3333	7.17741	2.07194

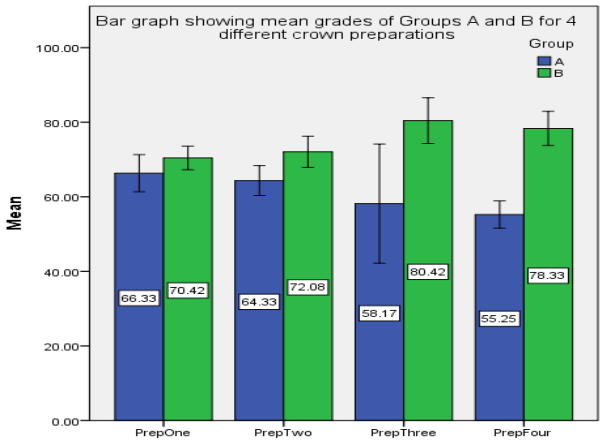

FIGURE 1: Clustered bar graph showing mean grades of students in group A and group B for different crown preparations.

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DISCUSSION

In this study, we compared the virtual and manual preclinical crown preparations of second year dental students and found that the 1st tooth preparation of both the groups A and B were similar, but all the subsequent tooth preparations of Group B were significantly better than those of Group A. Thus the null hypothesis that there would be no difference between the two methods of preclinical crown preparation, was rejected.

We conducted this research with second-year dentistry students to eliminate any potential bias based on prior experience. Both groups received similar grades for the first crown preparation. However, the subsequent grades of the second year BDS students indicated that the simulator was more effective in teaching preclinical crown preparation skill. This result could have been due to the improvement in the hand-eye coordination of the students because of the enhanced computerised visual system. Magnification of details aids in the students' cognitive acquisition of the task and boosts their confidence. Virtual reality also provides repeatability of actions, which can lead to enhancement of the quality of the tooth preparation. Also, the students who used a simulator were able to execute tooth preparation with less iatrogenic harm. However, the results of (22) were in contrast to the current study, wherein initially the grades were better for the haptic simulator system for cavity preparation, and towards the end the grades were similar for both the methods. This could have been because the students in their study performed cavity on the same tooth all four times.

Virtual reality-based training dramatically increased trainees' surgical ability and psychometric capabilities.(23) In various dental and medical sectors, haptic arm simulators have been effectively tested (24–30). The results of this study corroborated these findings and have shown that the learning curve of students in dentistry can be improved by the virtual reality preclinical training.

Limitations and Future Scope

This study had some limitations. Since it was conducted in a single dental college, the results of the study cannot be extrapolated to the students of all the dental colleges. Future studies should be done with different groups of students and with a larger sample size. Studies should also be done to evaluate the effectiveness of haptic feedback in other fields of dentistry like surgery, implantology etc.

CONCLUSION

Within the limits of this study, it can be concluded that haptic simulation is an effective tool in teaching crown preparation to pre doctoral dental students and can provide better training as compared to conventional crown preparation on typodont teeth.

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