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Research Article

Study on the Application of VR Technology in the Teaching of Dental Implantology

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Abstract

Objective: To explore the application of VR technology in the teaching of oral implantology.

Methods: Twenty students who have taken oral and maxillofacial surgery and oral implantology will be taught in a class. The selected students need to have some basic knowledge of oral anatomy. The first phase starts with traditional classroom teaching based on books, video recordings, animated demonstrations, flip charts, models, etc. and a course quiz and a course questionnaire are needed to be completed at the end of the class. In the second phase, VR oral implants will be taught and the course quiz and course questionnaire will be required again at the end of the class. A group discussion will be held for the students after the class to share their experiences and feelings in order to further analyze the advantages and disadvantages of VR technology in teaching oral implantology.

Results: Through the VR implant course, students get more hands-on opportunities. The combination of theory and practice deepened the familiarity with the implantation process and the control of the details of the implantation process. After the VR planting instruction, students' performance improved compared to the first stage and the evaluation of the VR course showed that the students were satisfied with the VR-guided oral implant course and had a good learning effect. The group discussion at the end of the course also showed support and expectation for VR teaching, but students believed that VR teaching could not completely replace hands-on practice, and that the immersive experience lacked some clinical specificity and response to unexpected situations.

Conclusion: In the era of rapid technological development, the application of VR technology in the teaching of oral implantology is promising. At the time of 5G popularization and epidemic normalization, virtual reality technology provides a positive help in teaching oral implants.

Keywords: *Oral Implantology; Virtual Reality; Teaching Methods; University Education; Implant Training*

Abbreviations

VR: Virtual Reality; COVID-19: Corona Virus Disease 2019; HMD: Head-Mounted Displays; BL: Blended Learning

Introduction

In such a context, a new teaching method, virtual reality (VR) teaching, has emerged. VR technology dates back to the United States in the 1960s [7,8], and the term "VR" was coined by Jaron Lanier [9] in 1989. It was only in 1990 that this technique became mainstream and attracted academic attention [10]. Virtual reality is defined as a computer system capable of creating and experiencing virtual worlds,

a system that creates a variety of virtual environments that affect the user's sense of sight, sound, and touch, giving them a sense of immersion [11]. Its characteristics can be summarized in four points: immersion, interactivity, conceptualization, and intelligence [12-14]. In traditional implant teaching, students' knowledge is acquired through textbook lectures, anatomical wall charts, surgical videos, and animated demonstrations. This traditional way of learning allows students to understand the interconnectedness of theoretical knowledge and anatomical structures in textbooks, both locally and as a whole, but at the expense of surgical experience. In addition, the cost of implant devices is extremely high, and the availability of human bone replacement material for implantation is limited, irreversible, and irreducible and does not reproduce the true jaw anatomy. Corona Virus Disease 2019 (COVID-19) epidemic has had a significant impact on the global population, economy, and healthcare systems worldwide, and education systems are facing serious challenges, and a new approach to education is urgently needed to ensure that students continue to A new approach to education is urgently needed to ensure that students continue to be taught [1-3]. In 2022, the new crown epidemic prevention and control are normalized, and distance learning gradually becomes a safe, reliable, and efficient education method [4-6]. In such a context, a new teaching method, virtual reality (VR) teaching, has emerged. VR technology dates back to the United States in the 1960s [7,8], and the term VR was coined by Jaron Lanier [9] in 1989. It was only in 1990 that this technique became mainstream and attracted academic attention [10]. Virtual reality is defined as a computer system capable of creating and experiencing virtual worlds, a system that creates a variety of virtual environments that affect the user's sense of sight, sound, and touch, giving them a sense of immersion [11]. Its characteristics can be summarized in four points: immersion, interactivity, conceptualization, and intelligence [12-14]. In traditional implant teaching, students' knowledge is acquired through textbook lectures, anatomical wall charts, surgical videos, and animated demonstrations. This traditional way of learning allows students to understand the interconnectedness of theoretical knowledge and anatomical structures in textbooks, both locally and as a whole, but at the expense of surgical experience. In addition, the cost of implant devices is extremely high and the availability of human bone replacement material for implantation is limited, irreversible, and irreducible and does not reproduce the true jaw anatomy. VR technology has become a top priority to drive development. VR technology is currently being used in a variety of fields widely used, most notably in gaming, film, simulation, therapy, training, education, collaborative work, and learning [15,16]. The first VR-based surgical treatment environments emerged in the 1990s as a highly cost-effective approach that allowed medical practitioners and students to identify and reduce errors at all times during the learning process [17]. Since the COVID-19 rampage in 2019, virtual reality has provided much help in preventing and fighting the current epidemic of COVID-19 [18]. In recent years, the development of VR has promoted the cause of stomatology education. At some universities in Latin America and European countries, haptic simulators are being used in conjunction with VR systems in stomatology to reliably mimic real sensations without having to physically touch them. This method is most widely used in the courses of endodontics and prosthodontics [19]. At present, the course of oral implantology guided by VR technology is still in the early stage of development. In the process of comprehensively deepening the reform of higher education in China, the teaching reform of oral implantology is imperative. This research group introduced VR technology into oral implantology teaching and conducted VR teaching training. The report is as follows.

Materials and Methods

Teaching objects

The teaching object is a class consisting of 20 students who choose "Oral and maxillofacial Surgery" and "Oral implantology". The class is equipped with two teachers and two teaching assistants to complete the course guidance and doubt-solving.

Teaching methods

Teaching is divided into two stages. In the first stage, students learn about oral implantology through books, wall charts, surgical videos, animations, and animal bone or model implant demonstrations. At the end of the first phase of the course, students fill in the satisfaction questionnaire and complete the planting test. In the second phase, Vives, the head-mounted displays (HMD) jointly developed by HTC of Taiwan and Valve of the United States, were used for VR-guided implantation training. HMD is a stereoscopic technology, which is worn on the head or as part of the helmet. In front of the user, there is a small optical display, which can be regarded as an enhanced display in front of the eyes, often bound to personal computers, smartphones, or other types of computing platforms [20]. Vive is an HMD connected

to a personal computer and equipped with two single-hand controllers to facilitate students to perform the implant operation with both hands. The HMD will guide the operation synchronically [21].

Teaching evaluation

After the completion of the first stage of traditional classroom teaching, students need to fill in the satisfaction questionnaire for the traditional planting course. After completing the second stage of VR planting teaching, the anonymous questionnaire should be filled in again. Ratings include: very satisfied, fairly satisfied, fair, not satisfied, and very dissatisfied. At the same time, a classroom test of implant implantation should be completed at each stage. According to the effect of implantation, the depth of implantation, the site, and the control ability of the implanted mobile phone were scored. Students gains from the course should also be considered comprehensively.

Statistical analysis

Statistical analysis was performed by SPSS20.0, count data were analyzed by frequency, and measurement data were expressed as ($x \pm s$). Wilcoxon rank sum test was used to compare course satisfaction, and $P < 0.05$ was considered statistically significant.

Results

Satisfaction survey

In the two-stage course, 20 students received conventional planting teaching and VR planting teaching. After each stage of the course, each student was asked to conduct an anonymous course satisfaction evaluation. The contents of the questionnaire include the interest, convenience, ease of operation, safety of the teaching method, as well as the help to curriculum understanding and practice. As for the evaluation results of the two-stage course, 3 people are very satisfied with the regular course, 7 people are satisfied, 8 people are average, 2 people are dissatisfied, and 0 people are very dissatisfied. For the VR course, 8 people are very satisfied, 11 people are satisfied, 1 person is average, 0 people are dissatisfied, and 0 people are very dissatisfied (Figure 1). The majority of students felt that VR teaching was more immersive, actually entering the surgical environment, and had more opportunities to operate without worrying about the consumption of materials. A small number of students (one person) thought that the change from the virtual narrow environment into the real space would cause slight discomfort to the eyes, and more exercises were needed to get used to it. But most students think this feeling is almost negligible. The difference between the two groups was statistically significant (Z = -2.961, P = 0.005).

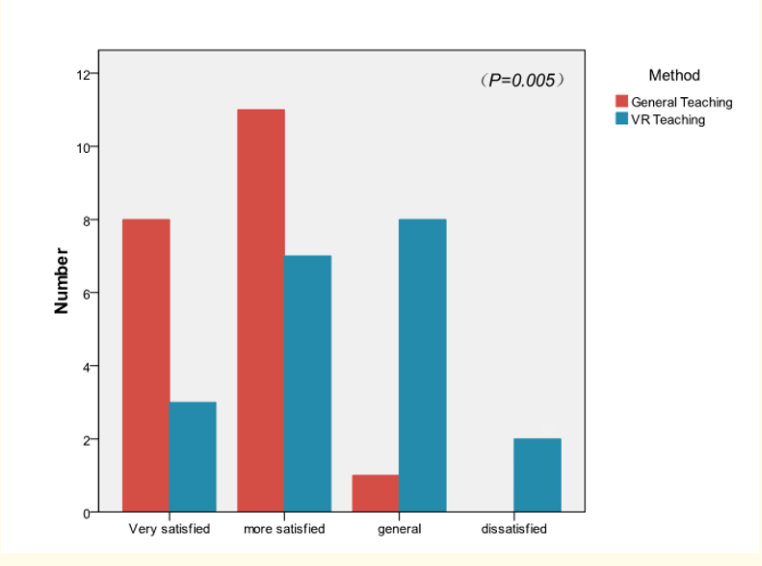

Figure 1: *Two-stage course satisfaction evaluation.*

Comparison of scores

At the end of each stage of the course, each student is required to take a course test, and each course test requires an implant to be implanted in the model to compare and analyze the results of the two-stage course test. In the classroom tests of regular courses, students generally showed that they were not familiar with the planting process, unfamiliar with the anatomical structure, had poor control of the planting phone, fixed point deviation, axial deviation, insufficient planting depth, or beyond the safe range, long time, waste of materials and other deficiencies. In the course test after the VR planting course, the students all showed great improvement in the planting process. And anatomy is mostly memorized. Especially for the control of implant position and perspective, it shows certain traces of training and accumulation of experience. The boxplot shows that the average score of the classroom test for the regular course is 78 points, while that for the VR course is 88.05 points. There was a statistical difference in scores between the two groups (P = 0.037). The scatter plot showed that VR classroom test results were more concentrated and significantly improved compared with conventional teaching (Figure 2).

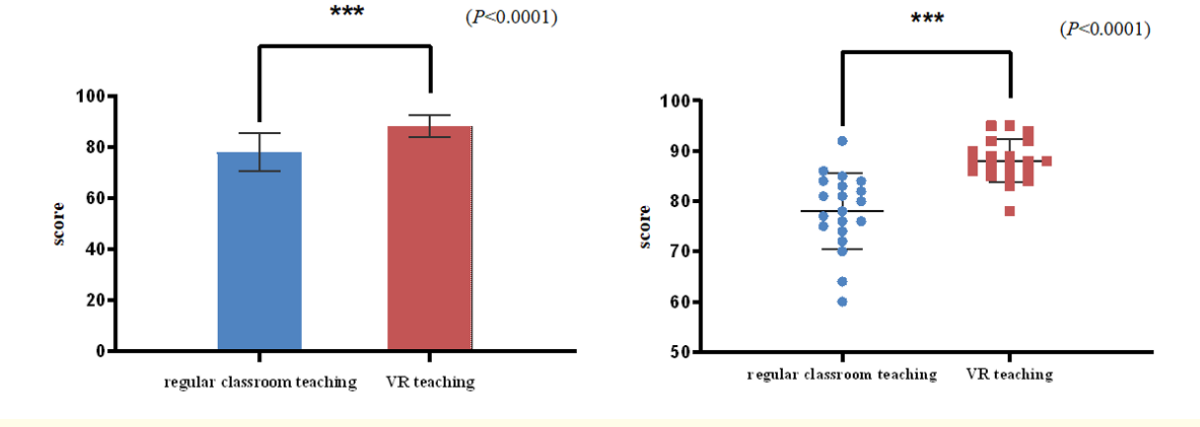

Figure 2: *Bar chart and scatter chart of comparison of test scores in the two-stage course.*

Discussion and Conclusion

Advantages of VR planting teaching

The virtual environment created with Vive contains the key points of knowledge that need to be taught to students, guiding them to receive information from the virtual environment through sight and sound, increasing their interest in learning, and making them active.

Use your imagination and creativity to participate in learning [22,23]. Most importantly, VR implantation teaching reduces the cost of equipment and materials, allowing each student to practice several times. Through this pre-clinical training, students are more familiar with the whole implantation process and reduce mistakes. Today, given the limitations of social distancing, VR will become even more important as a unique educational and training resource. VR can even allow students to fully immerse themselves in the clinical environment without leaving home [24]. Such as today's hybrid learning (BL) will be different learning theories, learning resources, learning environments, Learning styles, traditional face-to-face teaching and new E-Learning teaching integration [25], virtual reality teaching is the embodiment of mixed learning. In a VR classroom, when a student or teacher acts, all participants can see the process through the display screen, which enhances classroom interaction. In class, teachers can show a real case for students to analyze, which is helpful to cultivate students' thinking and practical ability to solve problems. An ideal course should include the following basic content: ① Timely feedback to teachers and students; ② Student scan is repeated training; ③ Make simulation part of students' curriculum; ④ Integration

of operational and theoretical courses; ⑤ High degree of simulation operation. Vr-guided implantology courses are a good blend of the above advantages [26].

Deficiencies and improvements in VR planting teaching

With the development of VR technology, the price of VR devices has been reduced, but it is still far from common use. At the undergraduate level, most students still have to rely on schools and teaching institutions to use VR devices for training. For doctors who need further education, VR devices are a good medium to receive remote teaching, compared to video teaching has irreplaceable advantages, and many doctors do not have the opportunity to train in implantology. To meet the increasing demand of students for VR teaching, virtual programs also need to make continuous progress to achieve a more suitable degree of imitation. Compared with traditional classroom teaching, VR implant teaching is more convincing and can mobilize the learning atmosphere, but it still cannot replace real implant surgery. In the group discussion after class, the students also said that although they had a high degree of satisfaction with VR teaching, the model established by VR could only show the commonness of the complexity and particularity of the patient's anatomical structure, presenting the disadvantages of a single and fixed model, which could not replace the changeable conditions in real surgery.

Future teaching trend

Oral implantology has developed rapidly in recent years, but only dentists with rich clinical experience can perform complex clinical operations [27]. Because the implant surgery is complicated, it needs to be done in the narrow mouth Operation, and the distribution of important blood vessels and nerves in the maxillofacial region is staggered and complex, and any mistake in the operation process will lead to serious consequences. Therefore, it is particularly obvious to be familiar with the anatomical structure of these parts, and repeated implantation training is Important.

In summary, with the rapid development of VR technology, VR technology has been widely used in oral implantology teaching, and the teaching model has changed unprecedentedly. Current research has found that virtual simulation education can improve students' performance in implantology [28]. VR implantation teaching transforms the complicated oral and maxillofacial anatomy, complicated implantation process, and tiny intraoperative details into accessible images in the virtual world. The controller in the hands of students can even feel the moment when the gum is cut, the high-speed rotation of the implant phone, the resistance of the drilling needle in the alveolar bone, and the cutting sensation of different types of bone. More importantly, VR planting teaching allows students in need to be free from the limitations of time, space, and equipment. VR is a powerful educational tool that continues to integrate traditional curricula and develop technologies that can share simulated clinical experiences, which will facilitate high-quality cross-professional education and change the way we teach future clinicians [29]. In the future, oral implanting education needs to incorporate virtual reality into the training content, attach importance to the combination of theory and clinical practice skills training, and cultivate qualified medical students for society.

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Conflict of Interest

The authors declare that there is no conflict of interest.

Bibliography

1. Nicola Maria., *et al*. "The socio-economic implications of the coronavirus pandemic (COVID-19): A review". *International Journal of Surgery* 78 (2020): 185-193.

2. Li Yanfang and Yuanyuan Niu. "A commentary on "The socio-economic implications of the coronavirus pandemic (COVID-19): A review". *International Journal of Surgery* 95 (2021): 106048.

3. Haroon Zainab., *et al*. "COVID-19 Era: Challenges and Solutions in Dental Education". *Journal of the College of Physicians and Surgeons--Pakistan: JCPSP* 30.10 (2020): 129-131.

4. Schneider Samantha L and Martha Laurin Council. "Distance learning in the era of COVID-19". *Archives of Dermatological Research* 313.5 (2021): 389-390.

5. Almarzooq Zaid I., *et al*. "Virtual Learning During the COVID-19 Pandemic: A Disruptive Technology in Graduate Medical Education". *Journal of the American College of Cardiology* 75.20 (2020): 2635-2638.

6. Chiodini Jane. "Online learning in the time of COVID-19". *Travel Medicine and Infectious Disease* 34 (2020): 101669.

7. Torous John., *et al*. "The growing field of digital psychiatry: current evidence and the future of apps, social media, chatbots, and virtual reality". *World Psychiatry: Official Journal of the World Psychiatric Association (WPA)* 20.3 (2021): 318-335.

8. Izard Santiago González., *et al*. "Virtual Reality as an Educational and Training Tool for Medicine". *Journal of Medical Systems* 42.3 (2018): 50.

9. Winston PH. "New Progress in Artificial Intelligence". *New Progress in Artificial Intelligence* (1974).

10. Hoppe Hugues. "Smooth view-dependent level-of-detail control and its application to terrain rendering". *Proceedings Visualization*98 (1998).

11. Blach Roland. "Virtual reality technology-an overview". *Product Engineering: Tools and Methods Based on Virtual Reality* (2008): 21-64.

12. Tudor Car Lorainne., *et al*. "Outcomes, Measurement Instruments, and Their Validity Evidence in Randomized Controlled Trials on Virtual, Augmented, and Mixed Reality in Undergraduate Medical Education: Systematic Mapping Review". *JMIR Serious Games* 10.2 (2022): e29594.

13. Rosmansyah Y., *et al*. "A systematic review of virtual reality application in anatomy studies". *The 5th Biomedical Engineering's Recent Progress in Biomaterials, Drugs Development, And Medical Devices: Proceedings of the 5th International Symposium of Biomedical Engineering (ISBE) 2020* (2021).

14. Choi Jeeyae., *et al*. "Effectiveness of Immersive Virtual Reality in Nursing Education: Systematic Review". *Nurse Educator* 47.3 (2022): E57-E61.

15. Zhao Guanjie., *et al*. "The comparison of teaching efficiency between virtual reality and traditional education in medical education: a systematic review and meta-analysis". *Annals of Translational Medicine* 9.3 (2021): 252.

16. Garner Tom A and Tom A Garner. "Applications of virtual reality". *Echoes of Other Worlds: Sound in Virtual Reality: Past, Present and Future* (2018): 299-362.

17. Goo Hyun Woo., *et al*. "Advanced Medical Use of Three-Dimensional Imaging in Congenital Heart Disease: Augmented Reality, Mixed Reality, Virtual Reality, and Three-Dimensional Printing". *Korean Journal of Radiology* 21.2 (2020): 133-145.

18. Singh Ravi Pratap., *et al*. "Significant applications of virtual reality for COVID-19 pandemic". *Diabetes and Metabolic Syndrome* 14.4 (2020): 661-664.

19. Cayo CF., *et al*. "VR systems in dental education". *British Dental Journal* 228.10 (2020): 738.

20. Kim Nam., *et al*. "3D display technology". *Display Image* 1.1 (2014): 73-95.

21. Borrego Adrián., *et al*. "Comparison of Oculus Rift and HTC Vive: Feasibility for Virtual Reality-Based Exploration, Navigation, Exergaming, and Rehabilitation". *Games for Health Journal* 7.3 (2018): 151-156.

22. Xiaoying Lin and Su Xianbo. "The application of virtual reality technology in teaching reform". *Advanced Technology in Teaching: Selected papers from the 2012 International Conference on Teaching and Computational Science (ICTCS 2012). Springer Berlin Heidelberg* (2013).

23. Mao Randi Q., *et al*. "Immersive Virtual Reality for Surgical Training: A Systematic Review". *The Journal of Surgical Research* 268 (2021): 40-58.

24. Sukotjo Cortino., *et al*. "Development and student perception of virtual reality for implant surgery". *Education Sciences* 11.4 (2021): 176.

25. Vallée Alexandre., *et al*. "Blended Learning Compared to Traditional Learning in Medical Education: Systematic Review and Meta-Analysis". *Journal of Medical Internet Research* 22.8 (2010): e16504.

26. Nassar Hani M and Ara Tekian. "Computer simulation and virtual reality in undergraduate operative and restorative dental education: A critical review". *Journal of Dental Education* 84.7 (2020): 812-829.

27. Cheung MC., *et al*. "Implant education patterns and clinical practice of general dentists in Australia". *Australian Dental Journal* 64.3 (2019): 273-281.

28. Zhang Baoping., *et al*. "Virtual versus jaw simulation in Oral implant education: a randomized controlled trial". *BMC Medical Education* 20.1 (2020): 272.

29. Pottle Jack. "Virtual reality and the transformation of medical education". *Future Health Care Journal* 6.3 (2019): 181.

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