

Validation of Digital Evaluation in Systematic Training on Tooth Preparation in Aesthetic Veneer Rehabilitation

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Objective: To evaluate the outcome of systematic video training on tooth preparation in veneer restoration and the practicability of the application of the digital evaluation system of scan design and assessment software.

Methods: Ten residents were selected from a group enrolled on the first-year programme for the National Standard Training of Dentistry in the Department of Prosthodontics, College of Stomatology, Ninth People's Hospital Affiliated with Shanghai Jiao Tong University, School of Medicine. First, each student prepared five teeth based on their knowledge and clinical experience, and then received systematic video training on veneer preparation. Before and after the training, the evaluation of the effects of training was conducted on the prepared teeth by measuring the continuity of the finishing line and tooth reduction amount automatically using the prepCheck 2.0 (Dentsply Sirona, Charlotte, NC, USA) CAD/CAM system.

Results: The results showed a significant difference in the quality of finishing line continuity pre- and post-training. Furthermore, the data for tooth reduction after training, which met standard values, improved remarkably, increasing from $32.40 \pm 7.82\%$ to $60.50 \pm 5.48\%$.

Conclusions: Video training could significantly enhance the quality of tooth preparation for veneers. Moreover, the digital evaluation system could serve as an ideal alternative for tooth preparation evaluation for preclinical students, offering new insights for clinical education.

Key words: aesthetic rehabilitation, CAD/CAM, digital evaluation system, tooth preparation
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Tooth preparation is a common and fundamental procedure in prosthodontic clinical practice which requires the consistent integration of theoretical knowledge and

psychomotor skills¹. The outcome of tooth preparation plays a vital role in the fabrication of fixed restorations, such as crowns and veneers, and subsequently influences the quality of a restoration². It is therefore essential to evaluate the quality of tooth preparation, particularly for preclinical dental students and residents, who represent a significant group in the current dental education system. Previously, when training dental students to perform standard preparations, evaluation regarding preparation parameters was always conducted by the assessors or instructors in a subjective manner, making it difficult for students to fully understand standard preparation shape and form objectively³.

With the rapid development of the use of digital technology in dentistry, the CAD/CAM system has become an ideal substitute approach to determine preparation features due to its convenience and sufficient reproducibility, which enables students to investigate the difference in numeric values between their prepared tooth and the correct one in an intuitive manner^{4,5}.

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Digital guidance with a 3D video for tooth preparation has also been a useful tool in showing the magnified and 3D prepared tooth characteristics to students, who find this approach more entertaining and stimulating^{6,7}. Some clinicians have become aware of the practicality of CAD/CAM and are seeking to investigate its application for the evaluation of tooth preparation; however, previous studies have focused mainly on crown preparation. In the present study, we sought to investigate its application in veneer preparation, which is more technique sensitive. This discipline focuses more on the correct reduction amount and marginal fitness, and most students think it is the hardest form of tooth preparation in their clinical experience. The present authors therefore speculated that the digital system could play a bigger role, and aimed to assess the effectiveness of digital guidance for tooth preparation to enhance preparation quality, particularly among students. Moreover, rather than the conventional subjective judgement by instructors, we tried to investigate the feasibility of use of CAD/CAM software to interpret the outcome of veneer preparation to find a way to provide students with fair judgement of their preparation and promote the development of dental education.

Materials and methods

Ten dental residents (four men and six women, mean age 23.13 ± 1.46 years) who had completed the dental curriculum and received their bachelor's degree were selected voluntarily from a group enrolled on the first-year programme for the National Standard Training of Dentistry in the Department of Prosthodontics, College of Stomatology, Ninth People's Hospital Affiliated with Shanghai Jiao Tong University School of Medicine. First, the residents performed a full ceramic veneer preparation on a central incisor mounted on a standard artificial model (Nissin, Kyoto, Japan) using their basic experience acquired from the conventional dental curriculum and internship at the hospital. All residents prepared five veneers on the same day, and the time allowed for each veneer was 30 minutes. Once the preparation was complete, the prepared teeth were scanned by an experienced doctor and all parameters were processed using prepCheck 2.0 (CEREC; Dentsply Sirona, Charlotte, NC, USA) and saved for subsequent evaluation. A yellow point appeared where there were sharp ridges or edges, while the smooth finishing line or region was marked in grey, indicating excellent continuity. The number of teeth with sharp ridges was recorded for each person. Next, the amount of reduction was visualised and green represented insufficient reduction, whereas

excessive preparation was displayed in red. The prepared region that met the criteria was displayed in blue, and the percentage of it in the whole prepared area was calculated.

After the first stage of preparation, a 10-minute instructional video was introduced to demonstrate the standard preparation process for veneers. The video included six elements: standard body position for preparation, armamentarium needed, guide groove for the incisal and labial side, incisal and labial reduction (the pattern for the incisal margin was a "feather" preparation), finishing the margins (lightly subgingival for the anterior teeth), and final preparation polishing.

The residents then repeated the preparation and finished five teeth according to instructions they were given previously, and the effect of the visual guidance was determined using prepCheck 2.0 as mentioned above. Statistical comparisons were performed using SAS statistical software (version 8.2, SAS Institute, Cary, NC, USA). $P < 0.05$ was considered statistically significant (Fig 1).

Results

Figure 2 intuitively displays the continuity of the finishing line. The number of teeth (mean \pm standard deviation) with sharp ridges or edges (displayed as yellow points) before residents received video education was 2.80 ± 1.14 for every five prepared teeth, approximately 56%. Regarding marginal fitness, the sharp edges that emerged during preparation could be a factor for stress formation, leading to fracture of veneers and microleakage in the long term and eventually contributing to restoration failure. This result indicated that, even though the preclinical students had been educated at a university with experienced teachers, they still risked failure in over half of the veneers they made on account of the sharp ridges during preparation. The quality of the finishing line was enhanced remarkably after they received video instruction; this was indicated by the result of 1.20 ± 0.79 teeth with sharp ridges in five veneers, and a statistically significant difference was recorded (Fig 3 and Table 1). As shown in Fig 4, there were two kinds of personality that potentially resulted in different preparation styles. Some students were so cautious that they prepared the teeth carefully and gently, leading to insufficient reduction (shown in green, Fig 4a). In contrast, others were precipitant and bold, causing excessive reduction (shown in red, Fig 4b). With the digital software, the amount of reduction and the area needing to be modified were apparent and intuitive to determine. Moreover, the percentage of prepared regions that met the criteria

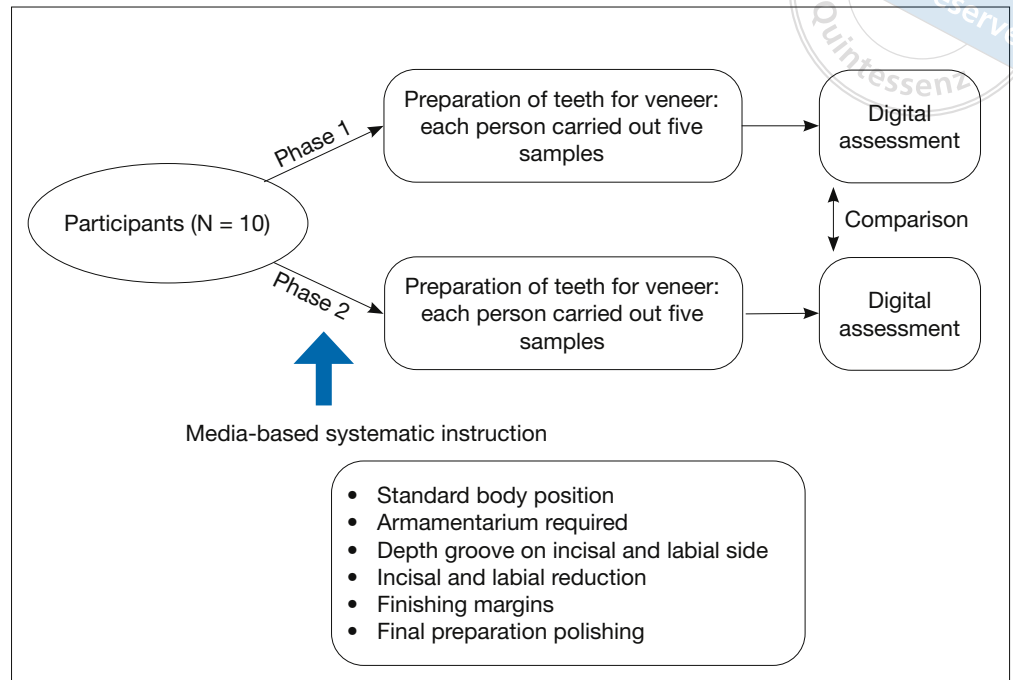


Fig 1 Illustration of the present study for assessment.

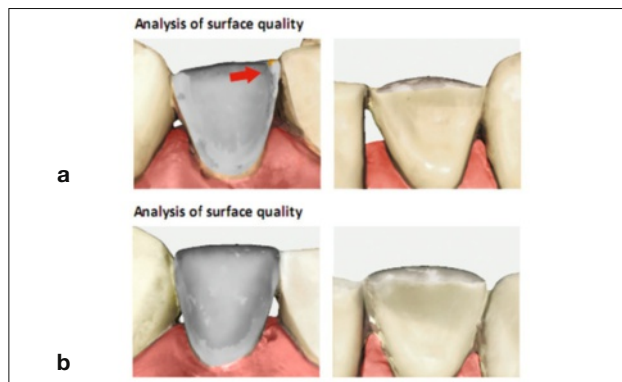


Fig 2 Analysis of the quality of the prepared surface of the veneer using prepCheck 2.0: (a) pre-training and (b) post-training. Sharp ridges or edges are indicated in yellow.

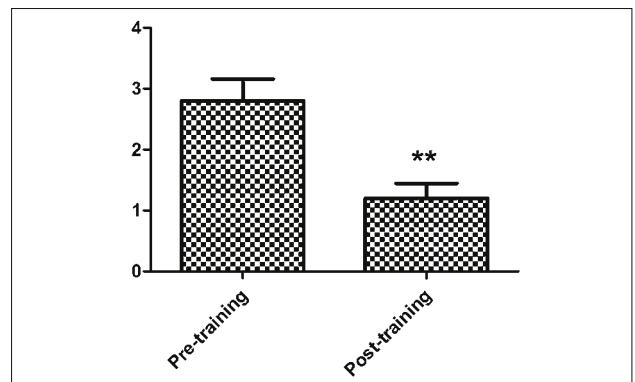


Fig 3 Number of teeth with sharp ridges or edges on the finish line between pre-training and post-training (five veneers prepared per person).

were $32.40 \pm 7.82\%$ and $60.50 \pm 5.48\%$ before and after receiving media instruction, respectively, and a significant difference was noted (Fig 5 and Table 2).

Discussion

Compared with preparation of the full crown, veneer preparation requires greater attention because it influences the subsequent thickness of the ceramic restoration pieces, leading to different outcomes, such as in terms of durability, colour and translucency⁸. As a result, veneer preparation is a core component of dental education, and it is essential to supervise the preparation and skill-based steps, particularly for students. The principle of veneer preparation focuses on preserving tooth struc-

Table 1 Number of teeth with sharp ridges or edges on the finish line between pre-training and post-training (five veneers prepared per person).

Residents	Pre-training	Post-training
1	2	1
2	3	0
3	3	1
4	2	2
5	3	2
6	2	1
7	1	1
8	4	2
9	5	2
10	3	0
Mean ± SD	2.80 ± 1.14	1.20 ± 0.79
Result	P < 0.05	

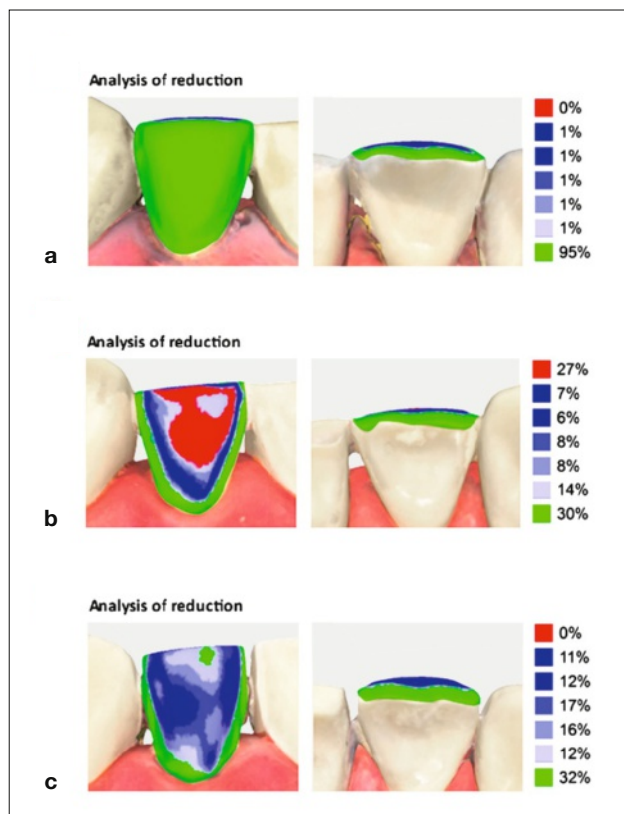


Fig 4 Analysis of reduction of the prepared surface of the veneer using prepCheck 2.0: (a and b) pre-training and (c) post-training).

ture as far as possible and providing ample restoration room to secure the rigidity of restorations, so that proper reduction and marginal fitness promote the longevity of restorations. However, in traditional practical teaching, the assessment of preparation is conducted by teachers and tutors, who inevitably display a significant degree of subjectivity. The silicone rubber guide fabricated prior to preparation serves as a good alternative to check whether tooth reduction is adequate using a periodontal probe, but it is not feasible to measure continuity of the finishing line, which is also difficult to determine with the naked eye⁹.

A previous study demonstrated that the CAD/CAM system was able to distinguish the variation in the amount of reduction and other parameters when a prepared tooth was scanned¹⁰. In the present study, as shown in Fig 4, the amount of reduction and the area needing to be modified using the digital software were apparent; this could overcome the shortcomings of silicone rubber guides and faculty assessment. The software could provide corrective measures before a bad habit was developed, which would have been difficult to change once it had been established. Moreover, the

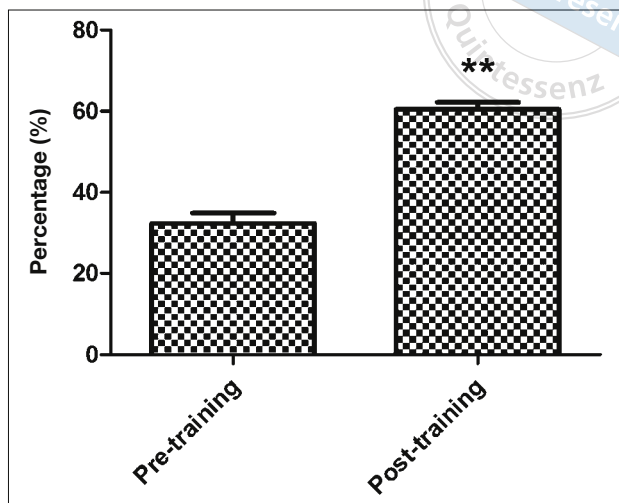


Fig 5 Percentage of the prepared region that met the criteria pre-training and post-training.

Table 2 Percentage of the prepared region that met the criteria.

Residents	Pre-training, %	Post-training, %
1	38	57
2	35	62
3	33	63
4	36	59
5	39	51
6	39	56
7	26	57
8	16	64
9	38	68
10	24	68
Mean ± SD	32.40 ± 7.82	60.50 ± 5.48
Result	P < 0.05	

introduction of a new assessment system, such as digital software, could appeal to students and help them pay more attention in class¹¹.

Traditional teaching approaches have been employed for decades and incorporated into the traditional pattern of dental education¹²⁻¹⁴. In the present study, prior to receiving video instruction, the residents learnt through a conventional teaching approach, conducted using the textbook “Prosthodontics (ed. 7)” published by People’s Medical Publishing House. Knowledge from the textbook was then illustrated by experienced teachers in their daily classes. However, manual skills training is difficult to administer on account of its complexity and objectivity, leading to greater adjustment being made to facilitate the transmission of knowledge and skills¹⁵. As technology advances, novice dental students prefer visual learning methods rather than textbooks alone; the former are more entertaining and stimulating

when it comes to mastering the concepts and criteria for a preparation procedure¹⁶. In the present study, an instructional video was created to enable residents to visualise and understand the concepts and criteria for tooth preparation intuitively. Moreover, it allowed for a pause after each step to receive instant feedback, offering the opportunity to combine theoretical and practical understanding for better learning outcomes.

The fact that approximately 56% of preparations did not meet the criteria prior to the video-based instructional teaching was surprising, and this could have been ignored in the everyday education system for the dental curriculum. It was linked to the way in which knowledge is transmitted in the traditional education system, which is based around theoretical skills and memorisation, with little practical function. Further, it was difficult for the teachers to get feedback from students until the preparation was completed¹⁷. After the instructional video, the quality of the finishing line and percentage of the prepared region that met the criteria were remarkably enhanced.

The present authors observed that preclinical practitioners tend to have difficulty completing aspects of specific clinical recommendations for veneer preparations, leading to a call for a change in the education system, which should focus on active learning instead of the dispensing of theoretical knowledge for learners to merely memorise¹⁸. A method integrating instructional teaching video and digital assessment could be beneficial for visualising manual mistakes and providing fair judgement of tooth preparation. The limitation of the present study was that it was conducted among a small group of dental students; an in-depth, larger-scale, longer-term cross-sectional study on the performance of students receiving this teaching method should therefore be conducted before its use is widely promoted for dental skills training^{19, 20}.

Conclusion

In conclusion, media-based training shows significant potential to enhance the quality of tooth preparation for veneer rehabilitation. The digital evaluation system is a practical and accessible approach that could objectively supervise clinical practice and enrich the teaching process, providing new insights for clinical education and operation.

Conflicts of interest

The authors declare no conflicts of interest related to this study.

Author contribution

Dr Qian Ju WU carried out the experiments and wrote the study; Dr Xiao WANG manipulated the CAD/CAM software; Dr Fei JIANG conducted the statistical comparison; Drs Di JIN and Zhi Sheng ZHANG delivered the dental curriculum for students; Dr Jin WEN revised the manuscript comprehensively; and Prof Xin Quan JIANG designed and supervised the study.

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