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CEREC Omnicam image quality following multiple cycles of dry heat sterilization

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CEREC Omnicam image quality following multiple cycles of dry heat sterilization

ABSTRACT

Background. The purpose of this study was to evaluate the potential effect of dry-heat sterilization of CEREC Omnicam stainless-steel sleeves on the accuracy of scans.

Methods. A prefabricated dental arch with an implant and healing abutment was scanned using three Omnicam sleeves. After the initial scan, the sleeves were processed in a dry heat sterilization unit and another scan was obtained. This was repeated for one hundred cycles. The scans were analyzed using MeshLab software to evaluate any deviation from the original scan.

Results. After one hundred cycles of dry heat sterilization there was no statistically or clinically significant deviation in quality from the original scan for all three sleeves.

Conclusion and Practical Implications. Further testing may be required to determine if there is any change in scan quality after more cycles of dry heat sterilization. Also, a standardized method of determining accuracy of scans may need to be developed.

Key Words. CAD/CAM, intraoral scanning, accuracy, Omnicam

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CAD/CAM (computer-aided design and computer-aided manufacturing) technology, in` dentistry, is used to produce different types of prostheses, including crowns, veneers, inlays, onlays, fixed dental prostheses, removable dental prostheses, dental implant prostheses, and orthodontic and other devices.[1] The use of CAD/CAM technology to produce "optical impressions" was first introduced in 1971.[2] In 1980, Dr. Werner Mormann of the University of Zurich proposed using this concept to produce chairside posterior ceramic restorations. On September 19, 1985, the first chairside inlay was completed at the University of Zurich Dental School.[3]

CEREC (Dentsply Sirona, York, PA) was the first commercially available intraoral scanner in the dental market. Since then, several intraoral scanning devices have been released. The CEREC AC with Omnicam is an intraoral scanning device widely utilized throughout U.S. Army dental treatment facilities. It was first introduced in 2012. The CEREC AC unit consists of the Omnicam camera for

image acquisition and a computer for design of the intended prosthesis. The Omnicam camera has a reusable stainless-steel mirror sleeve that must be sterilized between patients. According to Dentsply Sirona there two accepted means of sterilization of the Omnicam sleeve: high level disinfection or dry heat sterilization. U.S. Army protocol states that the Omnicam sleeves must be reprocessed by means of dry heat sterilization. The use of high-level disinfection has not been cleared by the FDA in the United States although Sirona has validated its use in Europe.[4]

Several studies have assessed the accuracy of CEREC Omnicam compared to other intraoral scanners in different clinical scenarios.[5-7] However, no study has evaluated the potential effect of dry heat sterilization on the accuracy of CEREC Omnicam scans. For this study, accuracy will be determined solely by trueness. Trueness is the closeness of agreement between the average value obtained from a large series of test results and an accepted reference value.[8] The purpose of this study was to evaluate the effect of multiple cycles of dry heat sterilization on the accuracy of CEREC Omnicam scans. The null hypothesis was that multiple cycles of dry heat sterilization would not have a significant effect on the accuracy of CEREC Omnicam scans.

MATERIALS AND METHODS

MODEL

A prefabricated plastic validation model was used to simulate human dentition. A Biomet 3i T3 4.1 x 10 mm implant (Zimmer Biomet, Warsaw, IN) and a Bellatek Encode 4.1 (D) x 5.0 (P) x 4.0 (H) mm healing abutment (Zimmer Biomet, Warsaw, IN) were placed in the model. The Encode healing abutment served as a known quantifiable landmark for calibration and analysis.

ACQUISITION AND STERILIZATION

In this study a CEREC AC with Omnicam using CEREC SW 4.6 was used. The Encode healing abutment was

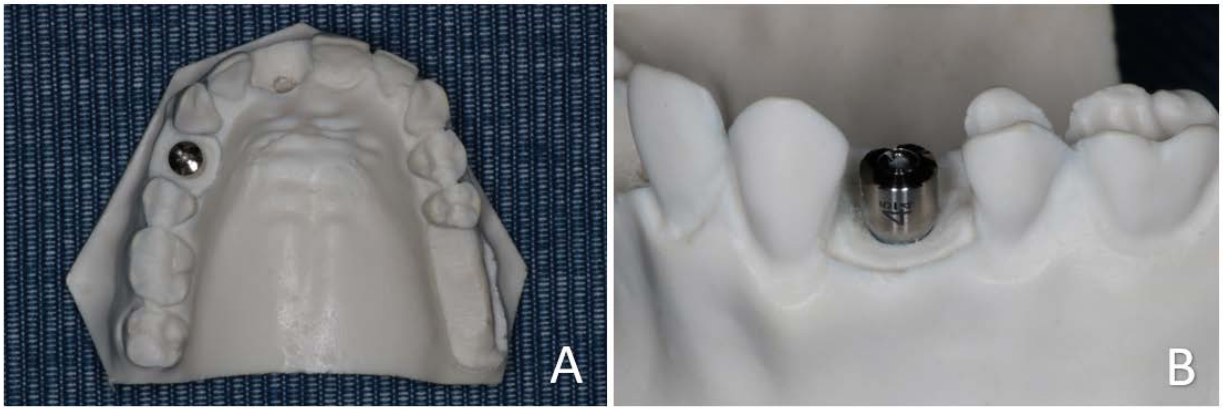

Figure 1. A, Model and healing abutment occlusal view. B, Model and healing abutment lateral view.

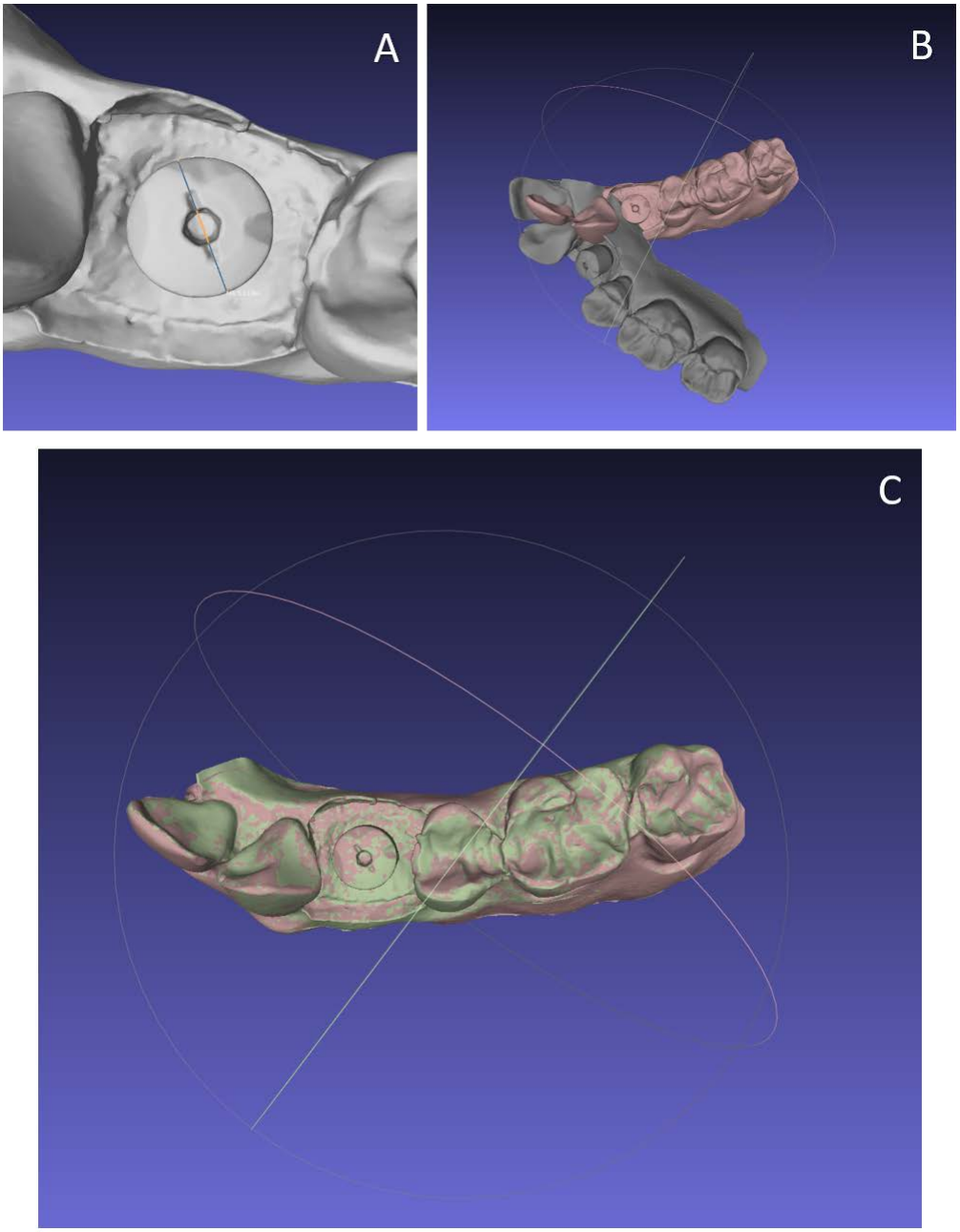

Figure 2: A, Calibration of the software. B, Initial import of the meshes. C, "Best fit" of meshes.

sprayed with CEREC Optispray (Dentsply Sirona, York, PA) to reduce scatter and facilitate scanning. Three unused CEREC Omnicam stainless steel mirror sleeves were utilized for this study. A pre-sterilization scan of the model was obtained for each sleeve to serve as a control. After the initial scan, the CEREC Omnicam sleeves were reprocessed using a Cox RapidHeat Sterilizer (CPAC, Leicester, NY). Cycle III, which is for wrapped instruments, was selected on

the sterilization unit. The cycle is pre-programmed for 12 minutes at 375°F (195°C). After sterilization, the first post-sterilization scan was captured for each sleeve. The process of sterilization and scanning was repeated for one hundred cycles for each sleeve. To prevent any inter-operator error, a single operator, familiar with the scanning device, performed the scans.

ANALYSIS

All scans were exported as highest resolution standard tessellation language (STL) files. The control, first post-sterilization, and one-hundredth post-sterilization STL files (meshes) for each sleeve were imported into MeshLab (CNR-ISTI, Pisa, Italy) for analysis. The software was calibrated for measurement using the 5 mm profile diameter of the Encode healing abutment as a reference. "Best fit" alignment was completed by MeshLab software after initial manual point-based alignment. Once aligned, the mean deviation between scans was determined using the "Process" function in MeshLab. To account for possible error within the software based on initial manual alignment, the alignment and deviation calculation was performed 10 times for each scan. The lowest deviation result, which represents the optimal alignment, was recorded for each scan for statistical analysis.

Statistical analysis was carried out using SPSS Statistics (IBM, Armonk, NY). A paired samples t-test was performed for the first and one hundredth post-sterilization scans for each sleeve.

RESULTS

The correlation between the scan accuracy and number of dry heat sterilization cycles for each sleeve is shown in Figure 3. The null hypothesis was not rejected, there was no significant difference in scan accuracy after one hundred cycles of dry heat sterilization ($p = 0.225$, $\alpha = 0.05$). The deviation from the original scan for all sleeves ranged from 8 to 10 μm after one hundred cycles of dry heat sterilization. There was maximum change of 2 μm from the first post-sterilization scan to the one-hundredth post sterilization scan for all sleeves.

DISCUSSION

In previous studies, deviation of scanning was calculated by comparing linear measurements or by using 3D evaluation software that superimposed all scanned digital data.[9-10] These study designs have been used to compare deviation between different intraoral scanners; however, no studies evaluating the effect of dry heat sterilization on scanning accuracy for a particular scanner have been conducted. In this study, the accuracy of scanning was determined using an intraoral scanner and multiple cycles of dry heat sterilization of the scanner sleeves. As in previous studies, 3D software was used to superimpose and analyze the scanned digital data.

A threshold value needed to be established for the relevance of the acquired values to dentistry. For conventional fixed tooth supported prosthodontics, an accuracy value of <150

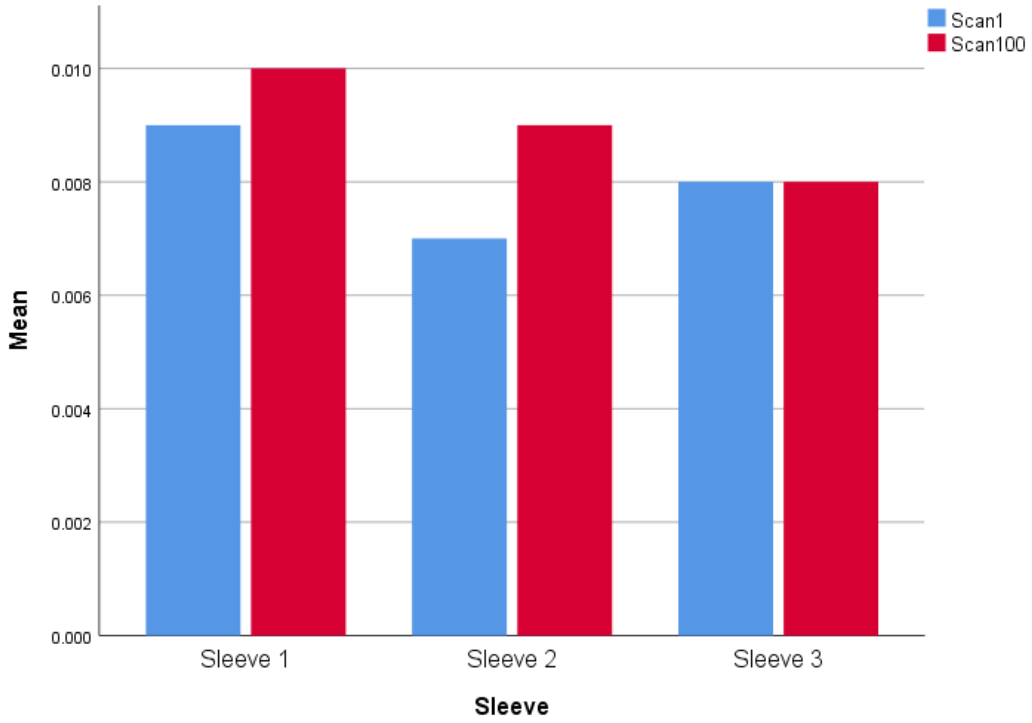

Figure 3. Mean difference (in millimeters) between the first and one hundreth post sterilazation scans for each sleeve.

µm may be favorable.[11] However, a study by Ahrberg et al concluded that the digital workflow is more accurate than the conventional workflow.[12] Based on that study more stringent tolerances can be applied to this study. Another study by Braian et al showed that the tolerance should be between 50 and 90 µm for implant supported restorations.[13] If the most stringent tolerance of 50 µm was applied, all values obtained in this study are well within the clinically acceptable range.

This study focused solely on the accuracy of the CEREC Omnicam and did not compensate for the design and fabrication process, factors that will add dimensional changes to the definitive restoration.

CONCLUSION

Within the limitation of this bench-top study it can be concluded that dry heat sterilization has no significant statistical or clinical effect on the accuracy of CEREC Omnicam scans after 100 cycles. ■

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