Short Communication

In Vitro Analysis of Laboratory-Processed and CAD/CAM-Generated Occlusal Onlay Surfaces

Sven Reich, Dr Med Dent[a]/Lars Trentzsch, DDS[b]/Stephan Gozdowski, DDS[c]/
Karl-Friedrich Krey, Dr Med Dent[d]

The purpose of this study was to evaluate the occlusion of all-ceramic onlay surfaces generated with a laboratory (LAB) and computer-aided design/computer-assisted manufacturing (COMP) system. The treatment of the mandibular left first molar was simulated on 16 casts. A minimum of three static contacts and their localization were defined beforehand (MIN3). The occlusal contacts obtained (CORR) were analyzed and the mean quotients (MIN3/CORR) for COMP- and LAB-processed restorations were calculated (1.06 ± 0.17 and 1.03 ± 0.13, respectively). The Wilcoxon signed ranks test revealed no significant differences (P <.05). *Int J Prosthodont 2009;22:620–622.*

When machinable ceramic blocks are used for full-contour restorations in computer-aided design/computer-assisted manufacturing (CAD/CAM) dentistry, it is of major interest that computer-generated occlusal surfaces need as little correction as possible after insertion, especially when using chairside technology. Nonphysiologic occlusal relationships can lead to impairment of oral health.[1] It is claimed that the biogeneric software can calculate missing occlusal shapes by vector space calculations, which are based on a deformable virtual average tooth dependent on the typical characteristics of the respective tooth type to be restored.[2] The null hypothesis in the present study was that there would be no difference between a chairside CAD/CAM technology using a biogeneric software and a laboratory system with respect to the number of contacts created on the occlusal surfaces of onlays.

Materials and Methods

Sixteen different mandibular casts made of acrylic resin (AlphaDie Top, Schütz-Dental) and the corresponding maxillary casts made of stone gypsum (esthetic-rock, dentona) representing caries-free dentitions with canine guidance were mounted in semiadjustable articulators (Contact Articulator, Lindauer Zähne) and served as patient simulation models. One articulator was provided for each pair of casts. The casts were not removed during the study. On the mandibular left first molar, a partial crown preparation was accomplished according to the guidelines for all-ceramic silicate restorations.[3] Before the preparation was done, a minimum of three stable occlusal contacts (MIN3) were defined that were desired on the future restoration, since clinical investigations in sound dentitions have revealed an average number of

[a]*Senior Lecturer and Senior Physician, Department for Prosthodontics and Dental Materials, RWTH Aachen University, Aachen, Germany; Visiting Dentist, Department of Prosthodontics and Dental Materials, University of Leipzig, Leipzig, Germany.*
[b]*Private Practice, Leipzig, Germany; PhD Student, Department of Prosthodontics and Material Sciences, University of Leipzig, Leipzig, Germany.*
[c]*Researcher, Department of Prosthodontics and Materials Sciences, University of Leipzig, Leipzig, Germany.*
[d]*Lecturer and Senior Physician, Department of Orthodontics, University of Leipzig, Leipzig, Germany.*

Correspondence to: *Dr Sven Reich, Department for Prosthodontics and Dental Materials, Medical Faculty, RWTH Aachen University, Pauwelsstrasse 30, D-52074 Aachen, Germany. Email: sreich@ukaachen.de*

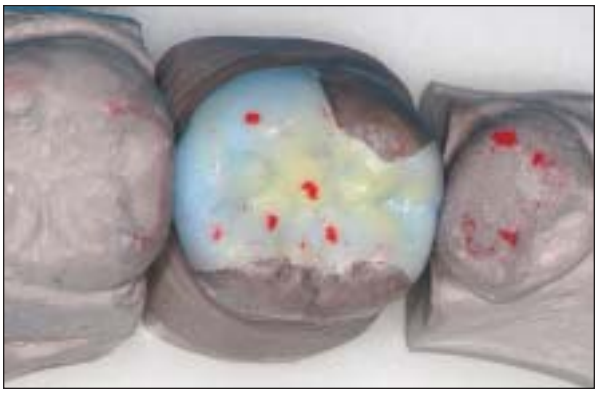

Fig 1a LAB method: Master cast and waxed-up onlay restoration. The contact points were created at the locations defined before treatment: central fossa, buccal cusp, and distal ridge.

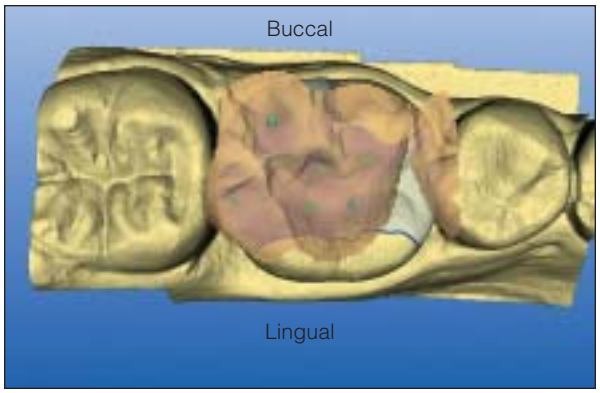

Fig 1b COMP method: Virtual 3D model of the preparation acquired directly from the simulation cast by optical impression and the superimposed static bite registration. Below the bite registration, the onlay restoration is visible, which was designed using the biogeneric software. The contact points, which penetrate the static bite registration up to 50 µm, are shown in green. Since the minimum number of three contacts was defined before treatment simulation and located in the central fossa, the buccal cusp, and the distal ridge, the virtual contacts were also placed in these locations.

Fig 2a LAB restoration after try-in and occlusal adjustment.

Fig 2b COMP restoration after try-in, glazing, and occlusal adjustment.

three contacts on molars.[4] They were located in the central fossa, on the distal ridge, and on the buccal cusp. Two restorations were produced for each cavity. The IPS Empress (Ivoclar Vivadent) method was applied to simulate the laboratory method (LAB). Impressions of the simulating casts were taken and the entire laboratory production process was accomplished according to manufacturer's instructions (Fig 1a). The Cerec 3D method (Sirona) was applied directly on the models to simulate a chairside treatment (COMP) by taking optical images of the preparation and of a static bite registration made of scannable, addition-curing polyvinyl siloxane material (Futar D Scan, Kettenbach). The restorations were designed using biogeneric software, version V 3.00 RC3 (Fig 1b).

After a proximal and internal try-in, the articulator was closed and contact of the adjacent teeth with their antagonists was checked with red 12-µm articulating foil (Hanel). In case of any missing contacts, the restoration had to be adjusted and polished until antagonistic contacts on the adjacent teeth were established. Simultanously, an attempt was made to retain or create those contacts on the restoration that corresponded (CORR) with the previously defined minimum number of three contacts (MIN3) (Figs 2a and 2b). The following quotients for LAB and COMP models were calculated:

$$QU_{LAB/COMPn1.....n16} = MIN3/CORR$$

and compared pair-wise with the Wilcoxon signed ranks test at $P < .05$.

Furthermore, the mean quotients (meanQU_{LAB} and meanQU_{COMP}) for n = 16 were calculated.

Table 1 Statistical Analysis of LAB and COMP Onlays

				Confidence interval	
Quotient	Mean	SD	Median	Lower	Upper
$MIN3/CORR_{LAB}$	1.03	0.13	1.00	0.97	1.10
$MIN3/CORR_{COMP}$	1.06	0.17	1.00	0.91	1.15

SD = standard deviation.

Results

The Wilcoxon signed ranks test revealed no statistical differences between the LAB and COMP onlays. Further statistics are presented in Table 1. Occlusal adjustment was necessary in 11 and 12 of the 16 cases for the LAB and COMP restorations, respectively. In 1 LAB and 2 COMP cases, the minimum number of three contacts was not achieved.

Discussion

To the authors´ knowledge there are no comparative studies on different restorative systems available with respect to occlusion. An in vitro setup was chosen because the procedure of occlusal analysis in the oral environment is associated with some shortcomings.[5] Due to the use of a rigid model comprising the articulator and casts, unlike under natural conditions, inaccuracies are not compensated for by the resiliency of the oral tissues. It has to be stated that the conclusions of an in vitro evaluation cannot be directly transferred to in vivo situations.

Conclusion

Within the limitations of this preliminary in vitro investigation, both systems demonstrated that it was possible to achieve satisfactory occlusal contacts. However, it would be desirable to verify these findings in an in vivo study.

Acknowledgment

This study was supported by Sirona Dental Systems.

References

1. Bryant SR. The rationale for management of morphologic variations and nonphysiologic occlusion in the young dentition. Int J Prosthodont 2005;18:284–287.
2. Mehl A, Blanz V, Hickel R. Biogeneric tooth: A new mathematical representation for tooth morphology in lower first molars. Eur J Oral Sci 2005;113:333–340 [erratum 2005;113:449].
3. Kunzelmann KH, Kern M, Pospiech P, et al. All-ceramic inlays, onlays, and posterior partial-coverage crowns. In: Kunzelmann KH, Kern M, Pospiech P, et al (eds). All-ceramics at a Glance. Ettlingen: Society for Dental Ceramics, 2007:9–15.
4. Riise C. A clinical study of the number of occlusal tooth contacts in the intercuspal position at light and hard pressure in adults. J Oral Rehabil 1982;9:469–477.
5. Gazit E, Fitzig S, Lieberman MA. Reproducibility of occlusal marking techniques. J Prosthet Dent 1986;55:505–509.