CAD/CAM Ceramic Overlays to Restore Reduced Vertical Dimension of Occlusion Resulting from Worn Dentitions: A Case History Report

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Two patients with a reduced vertical dimension of occlusion as a result of teeth wear were prescribed ceramic overlays. Their 2-year follow-up suggested good adaptation to the recovered muscle support without associated symptoms or adverse alterations in the restorations. *Int J Prosthodont 2017;30:238–241. doi: 10.11607/ijp.5146*

The diverse causes and time-dependent effects of worn dentitions may lead to reduced vertical dimension of occlusion (VDO) and associated clinical signs and symptoms of a temporomandibular disorder (TMD). Functional sequelae, such as compromised mastication and accompanying muscle soreness, are believed to result in alterations in muscle fiber composition and structural relationships,[1] and dental interventions are considered necessary to restore optimal function and address esthetic concerns. A compromised VDO is frequently managed with full-crown restorations and other methods, such as orthodontic treatment or splint-type removable prostheses. Recent advances in minimally invasive techniques, adhesive dentistry, and dentally applied digital protocols have made it possible to prescribe resin cement–retained computer-aided design/computer-assisted manufacture (CAD/CAM) overlay restorations as clinically simpler and less expensive alternatives.

This preliminary report on routine experiences with numerous patients in a university clinical setting is intended to encourage robust research that includes long-term outcome data. The authors routinely used lithium disilicate glass-ceramic CAD/CAM overlays on posterior teeth to increase the VDO by covering occlusal surfaces, and laminate veneer crowns (buccal veneers for shallow anterior overjet and lingual veneers for deep anterior overjet) to establish anterior occlusal guidance. The premise was that this restorative protocol provides a favorable clinical prognosis while increasing tolerance of the masticatory muscles to stronger biting forces. The clinical progress of two subjects is described to highlight the observed tolerance of the masticatory muscles to strong biting force before and after restoration. This was achieved by measuring constant biting time and content of blood oxygenation of the masseter muscle during biting.

Patient Reports

Two patients (49- and 68-year-old women) were randomly selected from a readily available completed patient treatment list. They had originally presented with chief complaints of postprandial fatigue and pain in the masseter and temporal muscles, dental wear, and tooth hypersensitivity. Their initial clinical examination revealed dental defects, moderate dental wear, and decreased VDO without clinical evidence of a TMD. Following a discussion regarding treatment options, both patients provided written informed consent for the following clinical management strategy: a stabilization splint to be worn for 3 months to recover the compromised VDO (about 2 to 3 mm at anterior teeth)[2] and evaluation of patient response and adaptability. Wax patterns of planned overlay restorations were tried in and the occlusion adjusted to provide anterior guidance without premature occlusal contact. The wax patterns were then scanned and lithium disilicate glass-ceramic (IPS e.max CAD, Ivoclar Vivadent) overlays for posterior teeth were fabricated with a CAD/CAM system (Cerec III, Sirona) while heat-pressed glass-ceramic (e.max Empress, Ivoclar Vivadent) lingual laminate veneer crowns were

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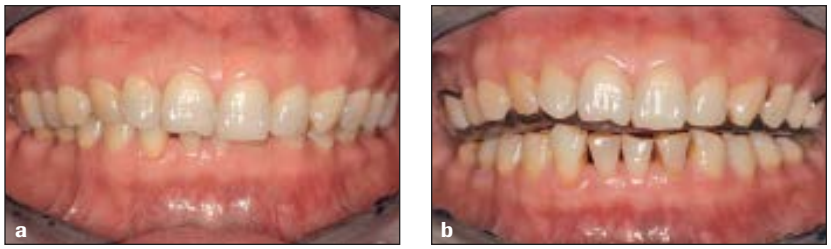

Fig 1 Subject 1 before restoration **(a)** and 3 months after placement of splint **(b)**.

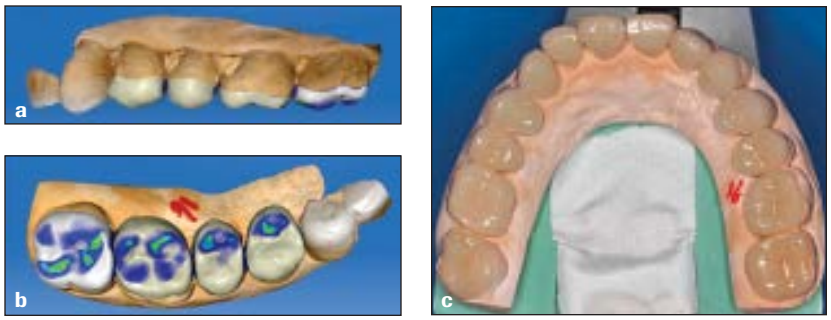

Fig 2 CAD/CAM designs **(a)** and fabrication **(b)** of lithium disilicate glass-ceramic overlays. **(c)** Anterior lingual glass-ceramic laminate veneers were heat pressed.

Fig 3 Frontal view after restoration.

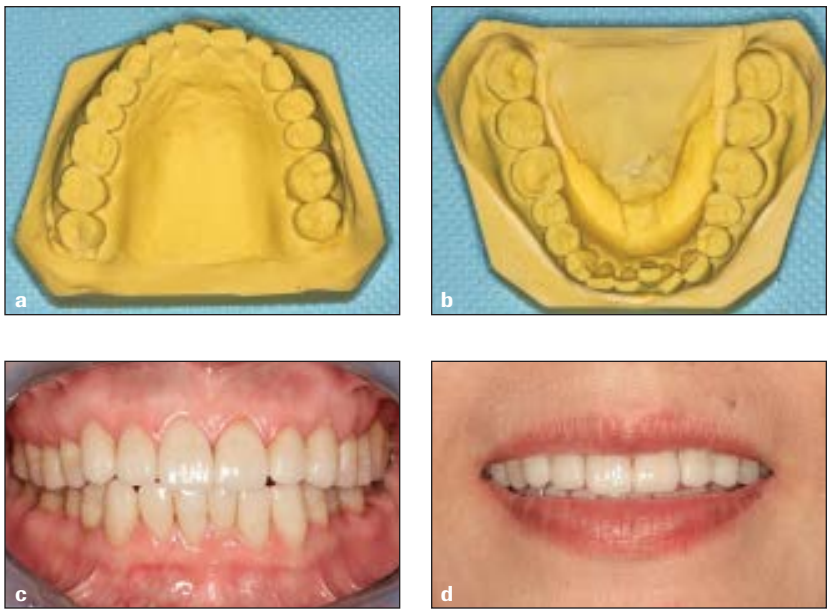

Fig 4 Heavy worn dentitions **(a and b)** of Subject 2 and intraoral **(c)** and facial **(d)** views after restoration.

fabricated for anterior teeth. The restorations were cemented on teeth with resin cement (Super-Bond C&B, Sun Medical). In Figs 1 to 4, both subjects' maxillary restorations—posterior overlays and anterior laminate veneers—can be seen.

Tolerance of the masseter muscles to strong biting force was checked by asking the subjects to bite down at 50% of the maximum biting force, as determined by visual biofeedback (electromyographic values) displayed on a monitor. They indicated when

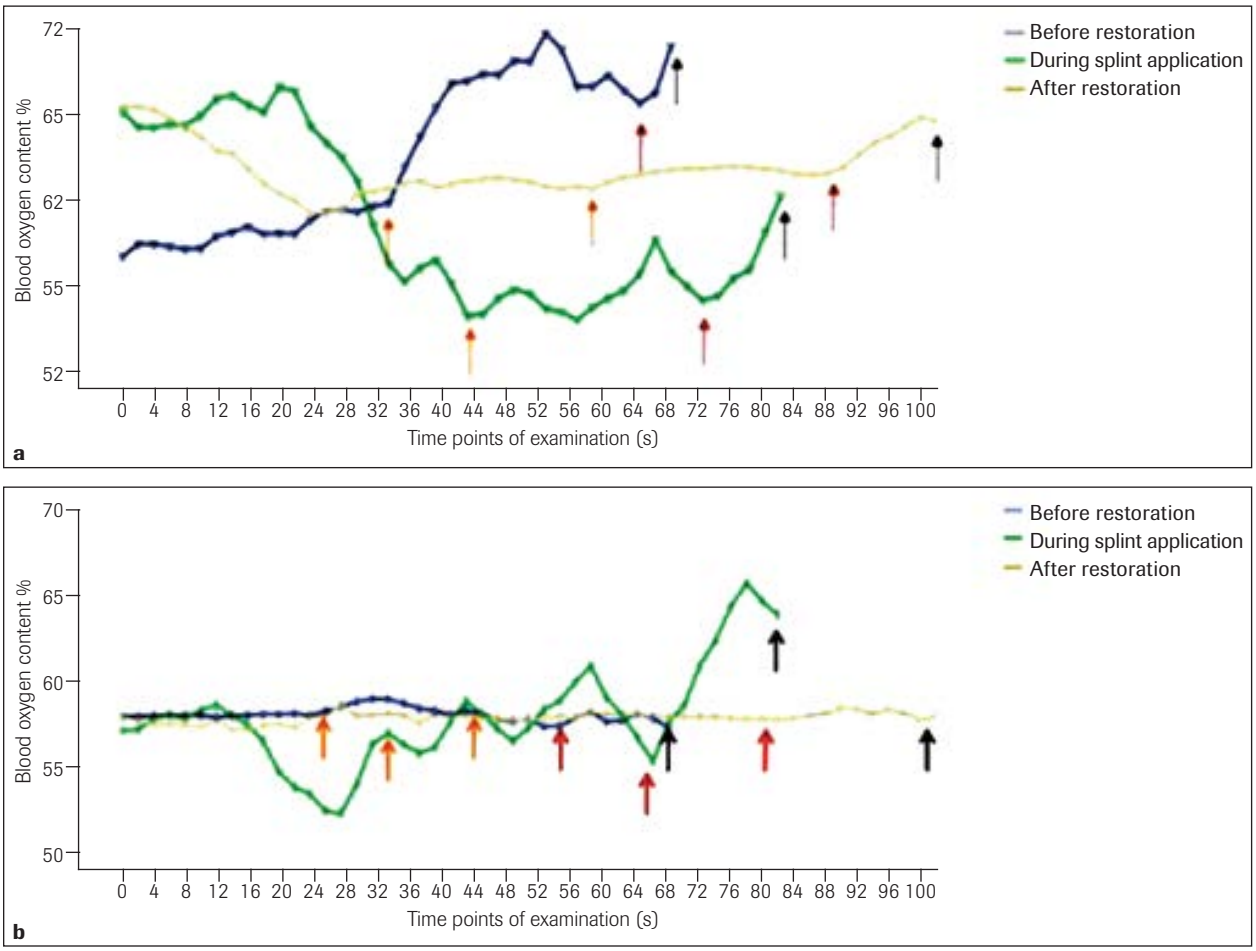

Fig 5 Blood oxygen contents (%) of the masseter muscles in two of the subjects (subject 1, **a**; subject 2, **b**) during strong biting before restoration *(blue line)*, during splint application *(green line)*, and after restoration *(yellow line)*. The orange arrows indicate the start points of fatigue, the red arrows indicate the start points of pain, and the black arrows indicate the cessation points of biting.

they felt muscle fatigue and muscle pain, and the time intervals from the initiation of biting were recorded. Noninvasive near-infrared spectroscopy (NIRS) (TSAM-100, Tshinhua University, China) was used to examine changes in blood oxygenation of the masseter muscle during biting. The test was evaluated at three time points—before restoration fabrication, 3 months after placement of the splint, and after restoration placement. Figure 5 shows constant blood oxygen content of the masseter muscles in both subjects during biting at these three time points.

Results

The two selected subjects were followed for 24 months at the time of this report's completion and had experienced no adverse treatment experiences (eg, fracture, loss of the prosthesis) or TMD-related symptoms.

The intervals from the initiation of biting to the onset of muscle fatigue and muscle pain in the two subjects after restoration increased by 9.3 seconds (SD 7.8 s; $P = .173$) and 14.7 seconds (SD 2.3; $P = .008$), respectively, compared with before restoration. The duration of tolerance from the onset of pain to the cessation of biting increased by 14.3 seconds (SD 11.1 s; $P = .154$).

Discussion

Fracture resistance and bond strength are two important factors affecting the clinical success of posterior overlay restorations. The CAD/CAM technique can be used to accurately fabricate prostheses using lithium disilicate glass-ceramic that has more comprehensive strength than glass-ceramic when used with resin cement, and more adhesive strength than zirconia.[3] Moderate tooth wear, as opposed to extensive enamel loss, is likely to provide enough enamel structure (at least around the occlusal table) to ensure reliable

adhesion and retention of the prosthesis. Observed outcomes of the described examples over a 2-year period of monitored recall indicate that the described technique met the clinical management objectives of no problems with the prosthesis and a successfully restored VDO and anterior occlusal guidance.

Muscle blood oxygenation is related to fatigue, and oxygenated hemoglobin/myoglobin concentrations, measured by NIRS, reflect muscle activity and antifatigue capacity.[4,5] Preliminary observations suggest that an increased VDO achieved by means of appropriate dental rehabilitation increased masticatory musculature blood oxygenation. This in turn delayed the onset of muscle fatigue and pain and increased the tolerance of the masseter muscles to strong biting force.

Conclusions

A 24-month follow-up of two female patients with CAD/CAM lithium disilicate glass-ceramic overlays was not associated with material fracture, loss of the prosthesis, or TMD-related symptoms. Moreover, masseter muscle fatigue and pain were not reported and an increased tolerance of the masseter muscles to stronger biting force was experienced.

Acknowledgments

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

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Literature Abstract

Genetic Variation May Explain Why Females Are Less Susceptible to Dental Erosion

It is known that not all individuals at risk for dental erosion (DE) display erosive lesions. The prevalence of DE is higher among male subjects. The occurrence of DE may depend on more than just acidic challenge, with genetics possibly playing a role. The aim of this study was to investigate the association of enamel-formation genes with DE. One premolar and a saliva sample each were collected from 90 individuals. Prepared teeth were immersed in 0.01 M hydrogen chloride (pH 2.2), and enamel loss was measured using white light interferometry. Mean enamel loss was 4.67 µm (range: 0.91–9.71 µm). Enamel loss was greater than the mean for 37 subjects (more susceptible) and below the mean for 53 (less susceptible). Of the 90 donors, 52 were female and 38 were male. Mean enamel loss for the specimens from male donors (5.12 µm; range: 2.51–9.71 µm) was significantly higher than for the specimens from female donors (4.34 µm; range: 0.91–9.27 µm) ($P = .047$). DNA was extracted from saliva, and 15 single-nucleotide polymorphisms were analyzed. Allele and genotype frequencies were related to the enamel loss of the specimens. Single-marker and haplotype analyses were performed using sex as a covariate. Mean enamel loss was higher for male donors than for female donors ($P = .047$). Significant associations were found between enamel loss and amelogenin, X-linked, tuftelin 1, and tuftelin-interacting protein 11. These genes are involved in different stages of the formation of tooth hard tissue, from enamel matrix formation to the mineralization and structural organization of the enamel. Analyses showed significant associations between variation in enamel-formation genes and a lower susceptibility to DE in female subjects. The results indicate that susceptibility to DE is influenced by genetic variation in enamel-formation genes, and may, in part, explain why some individuals are more susceptible than others to DE, including differences between female and male subjects.

Uhlen MM, Stenhagen KR, Dizak PM, et al. *Eur J Oral Sci* 2016;124:426–432. **References:** 34. **Reprints:** Marte-Mari Uhlen, Faculty of Dentistry, Department of Cariology, Institute of Clinical Dentistry, University of Oslo, P.b. 1109 Blindern, 0317 Oslo, Norway. Email: m.m.n.uhlen@odont.uio.no
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