Passivity of Fit of a Novel Prefabricated Implant-Supported Mandibular Full-Arch Reconstruction: A Comparative In Vitro Study

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Purpose: To quantify the strain development of a new prefabricated implant-supported mandibular full-arch reconstruction. Materials and Methods: Five resin models reflecting edentulous mandibles were each restored with three interforaminal implants and prefabricated frameworks with a novel compensation mechanism, cast frameworks, and computer-aided design/computer-aided manufacturing (CAD/CAM)-fabricated frameworks. Strains were recorded during superstructure fixation. Statistical analyses (analysis of variance, t tests; α = .05) were based on level of misfit and distribution of misfit. Results: Cast restorations showed significantly higher levels of misfit and a significantly more uneven distribution of misfit compared to prefabricated and CAD/CAM restorations (P < .05 for all comparisons). Prefabricated and CAD/CAM frameworks showed a similar low level and distribution of misfit (P = .24145 and P = .2837, respectively). Conclusion: The compensation mechanism of the prefabricated frameworks provides a level of fit comparable to CAD/CAM superstructures. Int J Prosthodont 2018;31:440–442. doi: 10.11607/ijp.5707

Misfit of implant restorations is a concern from a technical point of view and can lead to complications such as screw loosening or screw fracture.¹ Conventional superstructures have been shown to bear greater levels of misfit compared to computer-aided design/computer-aided manufacturing (CAD/CAM)-fabricated restorations.² Due to workflow,³ neither full-arch restoration type is suitable for immediate loading with a definitive prosthesis, but instead requires repeated interventions. To shorten treatment time, it would therefore be advantageous if a prefabricated definitive solution was available.⁴ To this end, a system with a novel compensation mechanism to adjust the fit of a prefabricated screw-retained framework has been introduced (Trefoil, Nobel Biocare AB) that is comprised of an array of curved discs utilized for establishing the implant-prosthetic interface (Fig 1a).

The purpose of this investigation was to quantify the strain development as indicator of the passive fit of this type of prefabricated framework for mandibular full-arch reconstructions in comparison to traditional restorations (cast and CAD/CAM).

Materials and Methods

Three interforaminal implants (NobelParallel CC Tissue Collar RP 5.0 × 13, Nobel Biocare AB) were inserted into five acrylic resin models (ProBase Cold, Ivoclar Vivadent) of an edentulous mandible. Implant sites were prepared using system-specific metal guides, and implant insertion was performed with a prefabricated template. In the cervical region, the osteotomies were enlarged and filled with an autopolymerizing resin (ProBase Cold).

For the prefabricated framework group (Trefoil group), transfer components were screwed onto the implants, splinted with resin (Pattern Resin, GC Germany), and used for pouring master casts in type IV stone (Fujroc, GC Germany). The prefabricated frameworks could then be fitted to the implant analogs. Once the compensation mechanisms had been secured, light-curing resin was applied to critical interfaces for permanent fixation (Rocatec Plus, Espe Sil, Sinfony, 3M ESPE).

For fabricating cast and CAD/CAM frameworks, transfer posts for closed-tray impressions (Impression coping closed tray, Nobel Biocare) were attached to the implants on the resin models. Impressions were obtained utilizing custom-made trays (Palaray XL; Heraeus Kulzer) and polyether material (Impregum, 3M ESPE) and used for fabricating master casts. For cast restorations (Group Cast), UCLA-type abutments (Gold Adapt, Non-engaging, Nobel Biocare) were attached to the analogs followed by waxing and casting using dental training alloy (Phantom-Metall NF, DeguDent). A silicone matrix reflecting the dimensions
of a prefabricated bar was used for waxing the cast bars. The master casts and the cast bars were subsequently scanned, and CAD/CAM frameworks (Group Procera) were milled from titanium (Procera Implant Bridge, NobelBiocare AB) (Figs 1b and 1c).

Six strain gauges (SG) (LY11-0.6/120; 120 Ω reference resistance; Hottinger Baldwin Messtechnik) were mounted on each in vitro model mesially and distally adjacent to the implants. A measurement amplifier (Quantum X; Hottinger Baldwin) combined with analyzing software (jBEAM; AMS Gesellschaft für angewandte Mess-und Systemtechnik GmbH) recorded the strains resulting from superstructure fixation2 (Fig 2).

A surgical motor (iChiropro, BienAir) was used for tightening the prosthetic screws to 35 Ncm at a speed of 30 rpm. For each restoration, the SGs were set to 0, the restoration was placed on the implants, and the screws were tightened in the following order: central implant, left implant, right implant. The final strain values after superstructure fixation were recorded.1

The absolute strain values served as the basis for statistical analyses. Two parameters were calculated for describing the passivity of fit: MEAN (mean of absolute strain values at different SG locations) for describing the level of misfit, and SD (standard deviation of absolute measurement values) for describing the distribution of misfit. Analysis of variance (ANOVA) and t tests (Holm’s P value adjustment method) for both parameters were used to compare the groups, with the level of significance set at α = .05. A post hoc power calculation revealed that for the parameters MEAN and SD, sample sizes of n = 3 and n = 4, respectively, are sufficient to compare Trefoil to cast restorations.

Results

The MEAN at the different SG positions ranged from 49.48 µm/m to 1,301.54 µm/m. The mean values and standard deviations for both MEAN and SD are given in Table 1.
Both MEAN and SD were significantly higher for the cast group compared to the Procera group (\( P = .00124 \) for MEAN and \( P = .0099 \) for SD) and to the Trefoil group (\( P = .00025 \) for MEAN and \( P = .0020 \) for SD). The Procera and Trefoil groups showed a comparable level of misfit (\( P = .24145 \)) and distribution of misfit (\( P = .2837 \)) Table 2.

### Discussion

While none of the restorations revealed a perfect fit (with the SGs recording 0 \( \mu m/m \)), the novel misfit compensation mechanism enabled a prefabricated framework to achieve a level of fit comparable to that of an individualized CAD/CAM restoration. While these results are not sufficient to predict the clinical performance of the novel prefabricated superstructures, behavior comparable to existing CAD/CAM restoration types with a high level of fit can be postulated.

The in vitro setting for this study and the limited sample size must be considered its most relevant limitations. In particular, the mechanical properties of human bone, which impact strain development in the peri-implant area, cannot be perfectly mimicked by the resin used for fabricating jaw models. Based on a previous study using an identical setup, clear differences in strain development between groups had been expected, and therefore a higher sample size was not deemed necessary.

### Conclusions

The compensation mechanism developed for Trefoil restorations allows for immediate restorations in edentulous mandibles at a level of superstructure fit comparable to that of an individualized CAD/CAM framework. As such, this treatment option may reduce total treatment time in these cases.

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### References