Enhancing the predictability of complex rehabilitation with a removable CAD/CAM-fabricated long-term provisional prosthesis: A clinical report

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Implementing any definitive prosthetic treatment of the residual edentulous ridge involves several risks. The patient's expectations may not be completely fulfilled as such treatment procedures include major changes in function and esthetics. Innovative materials, such as high-density polymers based on a highly cross-linked polymethylmetacrylate (PMMA) or composite resin for CAD/CAM-manufacturing are an alternative treatment option. They enhance the predictability of complex rehabilitations, especially in situations where the prognosis of the residual ridge behavior over time is challenging. This article describes an innovative approach of an extended pretreatment phase by using intraoral scanning and CAD/CAM technology for the fabrication of a long-term provisional removable dental prosthesis made of high-density polymer. (J Prosthet Dent 2012;107:1-6)

In clinical situations where a removable dental prosthesis is to be replaced by a fixed prosthesis, numerous variables regarding the adjustment of function, such as pink/white esthetics, phonetics, shape, and color, are of importance to the final result. Moreover, an estimation of the soft tissue behavior, especially for extensive restorations is challenging. Accordingly, after placing the definitive restorations, changing the treatment strategy is impossible, and patients may be disappointed with the final outcome.[1-4]

Generally, provisional restorations are a crucial diagnostic tool, in collaboration with the patient, to adjust variables in treatment results. In this context, innovative materials, such as high-density polymers based on a highly cross-linked polymethylmetacrylate (PMMA) or composite resin for Computer-Aided Design/Computer Aide-Manufacturing (CAD/CAM), have gained interest. Manufacturing under industrial conditions permits high-density-polymer-based restorations which offer favorable mechanical behavior and biocompatibility.[5] In addition, the restorations can undergo reshaping, adding, removing and repolishing procedures during the pretreatment.[6] These improved properties are better than those of traditional indirect provisional materials and allow new treatment approaches, such as an extended pretreatment phase.

To rehabilitate patients with a partially edentulous maxilla, conditioning the soft tissue is a key element for a successful treatment in the esthetic zone.[3] The creation of interdental papilla, which is dependent on the bone height,[7] and therefore, on the gingival response to the restoration conditioning[2] must be carefully assessed. However, clinical evaluation is a great challenge in the absence of a pretreatment phase with a provisional restorative treatment.[8,9] Accordingly, high-density, polymer-based provisional restoration can provide the opportunity to evaluate the newly defined restoration design in terms of function, phonetics, and esthetics.

CAD/CAM technology can be used for the fabrication of provisional restorations, which traditionally have been made of acrylic resin or composite resin materials, with or without fiber reinforcement in the dental laboratory.[10-13] In addition, since no substructure is required for reinforcement, milling high-density polymers to complete contour restorations simplifies the production process. Thus, CAD/CAM fabrication can be a cost-effective alternative to

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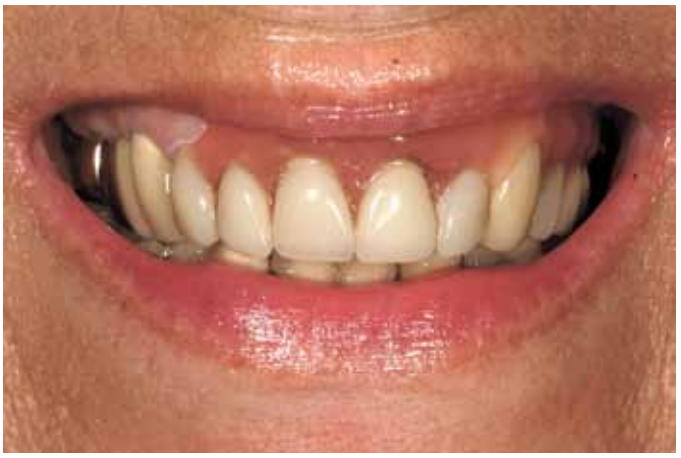
laboratory-manufactured, long-term provisional restorations.[14] Moreover, if any modification on the design is required, even to improve gingival conditioning, it can be cost-effectively performed by simple modification or replacement of the long-term provisional restorations. This clinical report describes the manufacturing of a removable CAD/CAM fabricated, long term provisional prosthesis made of high density polymer to enhance the predictability of a complex rehabilitation.

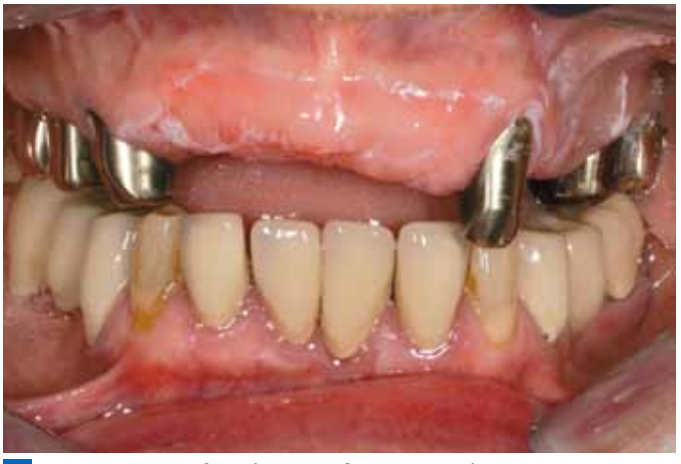
CLINICAL REPORT

A 60-year-old woman was referred to the Department of Prosthodontics at the Ludwig-Maximilians University in Munich. The patient requested replacement of her 15-year-old maxillary telescope crown-retained removable dental prosthesis (RDP) for a more esthetic and palate-free restoration. The esthetic appearance, in particular the shape and color of the denture teeth and the pre-existing palate-covered denture, was unsatisfactory to the patient (Fig. 1). Several treatment options, including an implant-supported fixed dental prostheses (FDP) to an implant-supported, palate-free RDP supported by telescopic crowns, were discussed with the patient. The high smile line, the thick gingiva, and the uneven anterior alveolar ridge made it difficult to estimate the surgical and prosthodontic effort necessary to achieve an esthetic outcome. The behavior of the soft tissue was of interest because it influenced the esthetic proportion of the anterior teeth. An important factor to consider was whether the patient needed ridge augmentation as a basis for a treatment with FDP, or if a removable solution would be a better method to achieve an esthetically satisfactory result.

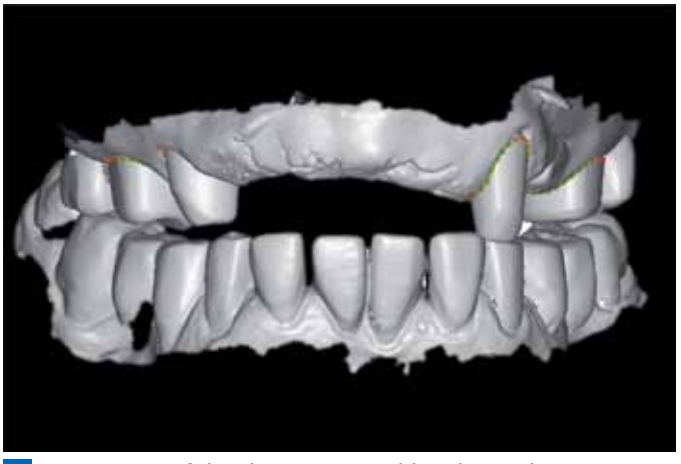
To assure high predictability of the final outcome of the definitive restorations, the restorative team decided in favor of an extended pretreatment phase. A CAD/CAM-fabricated removable dental prosthesis made from high-density polymer, supported by the preexisting telescopic crowns (first maxillary right molar, first maxillary right premolar, maxillary left canine, and first maxillary left molar) was planned (Fig. 2).



1 Preatreatment facial view with telescope crown-retained removable dental prosthesis.

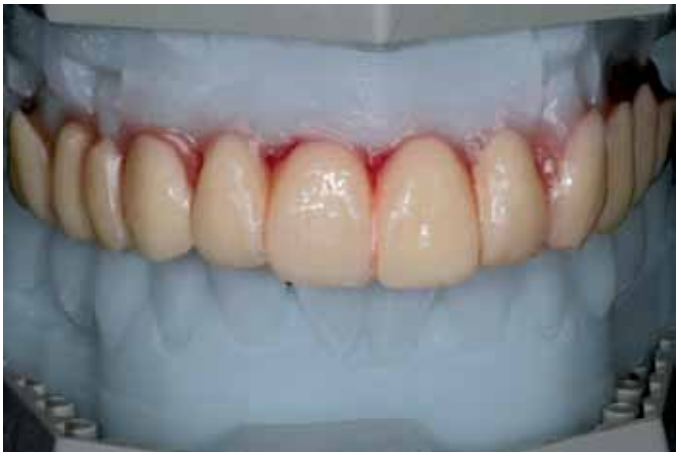


2 Pretreatment facial view of existing telescopic crowns after removal of telescopic denture.

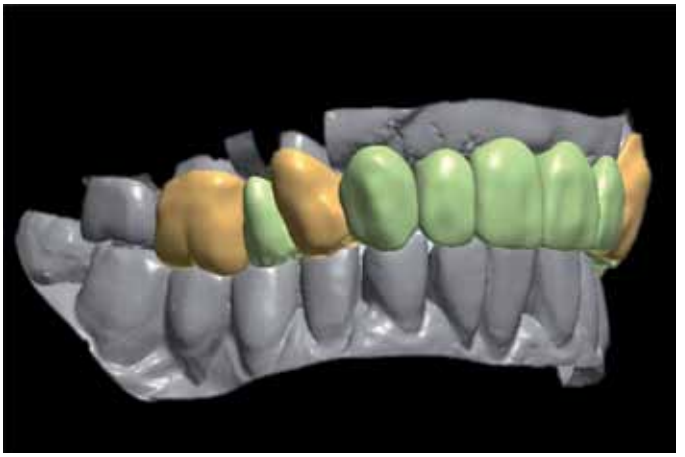


3 3-D image of the data captured by chairside scanner.

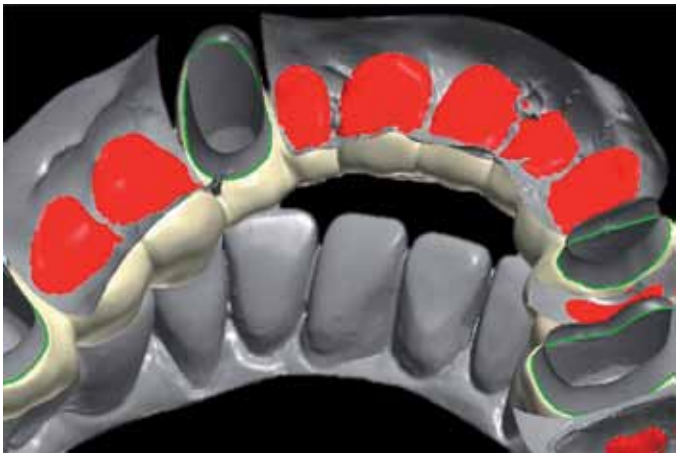
After removing the preexisting RDP, the intraoral scanning of the maxilla and mandible with a chairside intraoral scanner (Lava Chairside Oral Scanner COS; 3M ESPE, Seefeld, Germany) was performed. Since all maxillary and mandibular second-



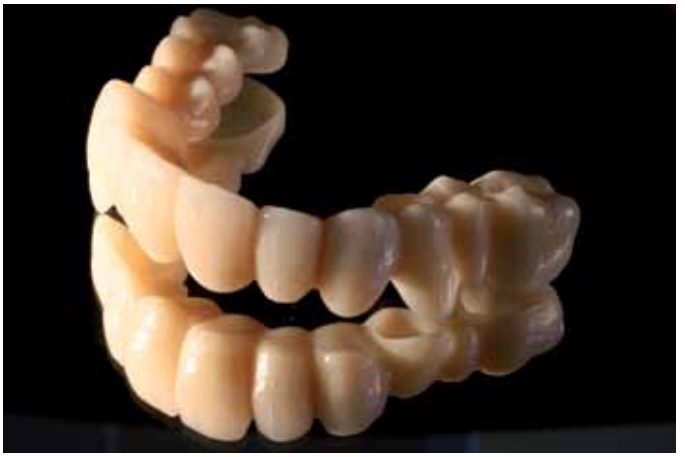
4 Complete arch waxing on stereolithographic cast.



5 Computer-aided design of removable prosthesis.



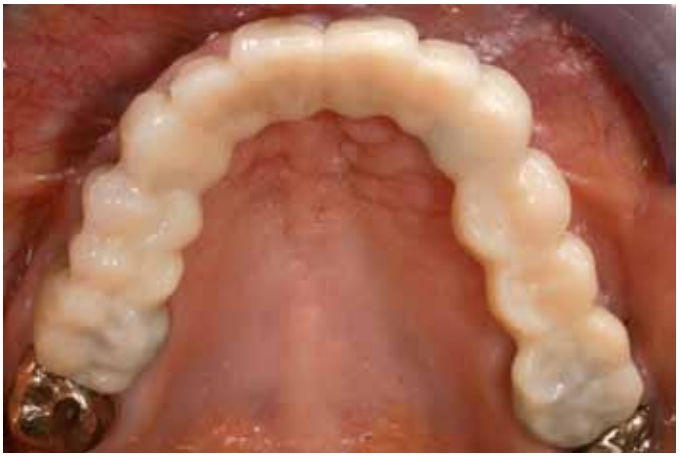
6 Basal view of CAD dataset for modifying form of pontics and determining depth of penetration into gingiva (red spots).



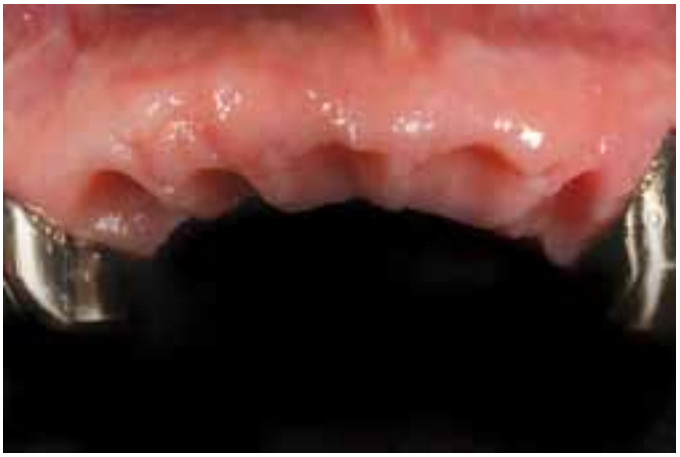
7 Milled and individualized long-term provisional removable prosthesis made of high-density polymer.

molars were present, 3 vestibular-scans (right, left, front) were made to capture the maxillomandibular relation and the dataset was transferred to an internet-based online portal (Lava Case Manager; 3M ESPE). After the dataset had been revised by the manufacturer (3M ESPE), it was downloaded by the dental laboratory technician to set virtual sections as well as for the determination of the preparation margins (Fig. 3). Then, the dataset was sent to the LAVA Case Manager for the second time, and a polymer cast fabricated by stereolithography (SLA-cast) was ordered. After receiving the SLA-cast at the dental laboratory, a complete-arch analytic waxing was completed (Fig. 4) and transferred into a 0.5-mm thick polyester-based diagnostic template (Duran; Scheu-Dental GmbH, Iserlohn, Germany). Subsequently, a first esthetic evaluation was accomplished by transferring the diagnostic template intraorally. Before placement, the preexisting telescopic crowns were isolated (low viscosity petroleum jelly), and the template was filed with a direct provisional material (Protemp 4 provisional crown and bridge material; 3M ESPE).

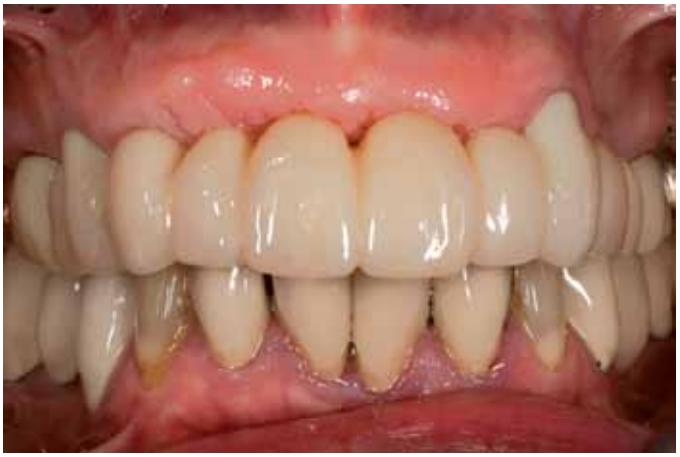
By using the analytic waxing as reference, the provisional removable dental prosthesis was designed with CAD software (DentalDesigner; 3Shape, Copenhagen, Denmark) (Fig. 5). The penetration depth of the pontics into the soft tissue of the edentulous ridge areas was determined virtually (Fig. 6) and the restoration-data was sent to a milling center. The restoration was milled by a 5-axis-milling machine from a PMMA-based high-density polymer-block (BeCe TEMP; BEGO Medical GmbH, Bremen, Germany). The milled restoration was customized in terms of function and esthetics by the dental technician (Fig. 7). The long-term high-density polymer prosthesis was then seated onto the pre-existing telescopic primary crowns without any luting agents (Fig. 8). The static and dynamic occlusion was verified and adjusted. Special attention was paid to the retention of the RDP to ensure a good pontic emergence profile on the gingival tissue. The goal was to find a balance between retention to form the emergence profile and to allow the patient to remove the prosthesis with ease. Retention was adjusted using composite resin (Sinfony; 3M ESPE), therefore, small box-like cavities (2 × 2 mm) were milled on the vestibular inner surface of each retainer of the RDP. After silicoating 30 µm, 1 bar, 5 seconds (Rocatec-Softond; 3M ESPE)



8 Provisional restoration milled from high-density polymer and supported by preexisting telescopic crowns.



9 Condition of anterior gingiva after 4 months.



10 Provisional prosthesis after 4 month of clinical service.

11 Facial view of provisional prosthesis. Preexisting telescopic crowns determined size of teeth.

and silanization (Sinfony Activator; 3M ESPE) the composite resin was applied into the box-like cavities and the restoration was seated. The composite resin was light-polymerized (Elipar S10 LED Curing Light, 1200 mW/cm^2; 3M ESPE) from the buccal direction through the restoration 3 times for 20 seconds each. Then, the retention of the prosthesis was adjusted by polishing these areas. The correct amount of mucosal pressure was verified by the blanching effect onto the soft tissue around the pontic after seating. After 5 minutes, the gingiva was adequately supplied by blood again and showed no discoloration compared to the surrounding soft tissue. The patient was instructed to remove the denture once a day to clean it and to brush the teeth 3 times a day. There were no diet restrictions except for extremely hard food, such as raw carrots.

To evaluate the gingival reaction and the retention of the prosthesis, recall examinations were performed at 3-week intervals. The intaglio surfaces of the pontics were modified by addition of composite resin (Sinfony) according to the given guidelines. The result of gingival conditioning and extraoral situation after 5 recall appointments is shown in Figures 9-11. Examinations were performed until no further enhancement of the clinical situation was achieved. Because of the unfavorable gingival/tooth esthetics, requiring ridge augmentation to enhance the width to length ratio of the teeth, the patient and the restorative team opted for a removable, implant-supported, telescopic dental prosthesis as the definitive restoration. This treatment alternative offered the opportunity to enhance gingival esthetics without surgical augmentation.

DISCUSSION

Generally, long term provisional restorations have demonstrated improvement in the esthetics and predictability of final clinical results.[9] The slight pressure provided by the pontics, which creates an adequate ovate pontic recipient site, including the formation of "pseudo" interdental papillae,[2] can be stimulated by modifications along the pretreatment phase. Furthermore, the feasibility of reshaping, adding, removing and re-polishing procedures on the long-term, provisional, removable dental prosthesis during the pretreatment

phase offers the possibility of modifying the restoration in accordance with the wishes of the patient. Such teamwork can be motivational for the patient given the opportunity to optimize the variable restoration outcomes in terms of function and esthetics.

Accordingly, PMMA or composite resin-based CAD/CAM-fabricated high-density polymers seem to offer adequate material properties as there was no need for fiber reinforcement or any substructure in the present situation. In addition, these materials can be milled precisely at the margins and in minimal thickness without compromising their strength or cracking during the milling process.

In the patient scenario presented, the manufacturing process is based on direct data captured by intraoral scanning. This could be accomplished because the maxillomandibular jaw relation was defined by the occlusal contacts of the second molars and did not require alteration.

For patients whose occlusal vertical dimension requires modification, direct data capturing and full digital workflow cannot yet be applied. The difficulty here is to place the SLA-cast into a digital articulator on the basis of digital axiography and to create precise static and dynamic occlusion. The individual components are already available, and the developers are working on appropriate interfaces. To broaden the indications of the full digital workflow in the future, 3-dimensional face-scan, digital waxing, and digital implant planning need to be better integrated. Furthermore, dentists and dental laboratory technicians need to be trained in such new treatment tools, protocols, and techniques.

The initial published studies regarding the accuracy of direct data capturing and conventional impressions and the personal experience of the authors suggest comparable precision of both techniques.[15,16] However, further research with respect to digital dentistry is required. The presented RDP showed precise fit on the telescopic abutment, and only minimal adjustments were necessary to achieve satisfying static and dynamic occlusion.

The uneven plane of occlusion (Fig. 5), because of the antagonist situation, is to be corrected by the definitive restorations, when the mandibular restorations will also be replaced. Then the waxing of the mandibular restorations will be performed according to the new restoration in the maxilla with the corrected occlusion plane. As the esthetic outcome in the posterior mandible region is not as important as in the maxillary anterior region, no evaluation by long term provisional restorations will be performed.

One major advantage provided by the CAD/CAM manufacturing of the RDP is that the location, shape, and extension of the pontics into the soft tissue of the residual ridge could be determined virtually (Fig. 6). In addition, in situations where a fracture of the provisional restoration occurs, the dataset will be available for a second milling process. Furthermore, the shape of the restorations can be used for the fabrication of the definitive prosthetics. The customized provisional restoration could be scanned after a prolonged clinical approval and digitally transferred into a definitive restoration. This facilitates the precise transfer of the contour of the provisional into a definitive restoration.

The cost for intraoral scanning, SLA-casts, and centralized milling of the removable dental prosthesis was about 500 USD. Further expenses for customization, finishing, and adjustments are dependent on the laboratory, dentist, and clinical situation.

SUMMARY

Because of the minimally invasive characteristic of the proposed prolonged pretreatment phase with CAD/CAM-fabricated high quality provisional restorations complex rehabilitations can be preevaluated with respect to function and esthetics. This results in higher predictability for the definitive restorations.

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Noteworthy Abstracts of the Current Literature

Retrospective cohort study of the predictors of implant failure in the posterior maxilla

Conrad HJ, Jung J, Barczak M, Basu S, Seong WJ.
Int J Oral Maxillofac Implants 2011;26:154-62.

Purpose. The purpose of this study was to retrospectively analyze a cohort of patients who had implants placed in the posterior maxilla and assess and identify the predictors of implant failure.

Materials and methods. With institutional review board approval, dental records from a population of patients who had maxillary posterior implants placed were used to create a database. Independent variables were divided into continuous (age of the patient at stage-one implant surgery [S1], time between extraction and S1, time between extraction and sinus augmentation, time between sinus augmentation and S1, time between S1 and stage-two implant surgery [S2], and the time between S2 and restoration of the implant) and categorical (gender, American Society of Anesthesiologists [ASA] status, current smoking status, implant position, implant proximity, residual crestal bone height, implant length and diameter, and sinus augmentation technique and materials). The dependent variable was implant failure, which was defined as complete removal of the implant. Simple logistic regression was used to assess the influence of each of the predictors on implant failure ($P < .05$).

Results. The final database included 504 maxillary posterior implants with an overall survival rate of 93.2% over a mean follow-up period of 35.7 months. For the continuous variables, the age of the patient at S1 was statistically associated with implant failure ($P = .028$), as was the time between extraction and S1 ($P = .014$). For the categorical variables, ASA status ($P < .001$), implant proximity ($P = .043$), residual crestal bone height ($P < .001$), implant diameter ($P = .050$), sinus augmentation technique ($P = .002$), and sinus graft materials ($P < .001$) were statistically associated with implant failure.

Conclusion. Within the limitations of this retrospective study, the results suggest that there are risk factors associated with maxillary posterior implant failure. Implants placed in areas with inadequate residual crestal bone height that required sinus augmentation were statistically associated with implant failure.