

DENTAL TECHNIQUE

A custom CAD-CAM resilient attachment: A dental technique

Elena Muehleemann, MD, DDS, Med. Dent,^a Jennifer GM Chantler, BDSc, DCD, MRACDS,^b
Mirsad Smajovic,^c and Franz J. Strauss, DDS, MSc, PhD^{d,e}



Implant-supported overdentures incorporating splinted or non-splinted attachment systems have been reported to be effective restorative options with high implant survival rates and patient satisfaction levels.¹⁻⁴ Bar attachments, although effective, come with drawbacks such as high cost, gingival hyperplasia, and encroachment on the prosthetic space.⁵ Bar attachments require additional clinical and laboratory steps to achieve a passive fit.⁶ For a removable implant prosthesis, a parallel path of insertion requires the inter-implant angulation to be minimal and perpendicular to the occlusal plane.⁷ A parallel path of insertion reduces attachment wear and maintenance costs.⁸ However, when working with existing implants not initially planned for a removable prosthesis, angled or custom retention elements become necessary.⁶

Digital technology enables the dental laboratory technician to streamline the design and manufacture of custom resilient attachments and a metal-acrylic resin implant overdenture prosthesis. By viewing the prosthesis in 3-dimensions during the design phase, it becomes possible to assess dimensions in cross-section, aiding in the creation of a more integrated and precise prosthesis. The ability to visualize the outcome, which incorporates multiple fabrication processes, streamlines and simplifies the manufacturing procedures.⁹ This comprehensive overview provides both the clinician and

ABSTRACT

Custom resilient attachments can be used for removable as well as fixed implant-supported prostheses, with the proposed tooth position being visualized in relation to the underlying metal framework, abutments, and implant positions. Custom resilient attachments and the framework for implant overdentures can be designed together using a computer-aided design software program. Computer-aided designed and computer-aided manufactured (CAD-CAM) custom resilient attachments offer greater angulation compensation than standard attachments when clinically required while accounting for biological, mechanical, and esthetic factors. Digital technology enables visualization of the outcome and streamlining the design and manufacturing of custom resilient attachments and a metal-acrylic resin implant overdenture prosthesis. The ability to customize abutments offers an additional restorative option to using stock resilient attachments. (J Prosthet Dent 2025;133:662-665)

dental laboratory technician with the confidence to execute the design throughout the treatment process.

The present article describes a clinical approach when dealing with significant inclinations between implants where the use of an angled stock resilient attachment is not feasible. The digital library of the LOCATOR attachment was incorporated into a custom CAD-CAM abutment to achieve this solution.

TECHNIQUE

A 68-year-old edentulous patient who had been wearing cement-retained implant-supported complete dentures in both his maxillary and mandibular arches presented with signs of peri-implantitis around several implants. Seeking to restore oral health, the prostheses were removed and treatment for the peri-implantitis initiated, resulting in the removal of 1 implant, leaving 4

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

^aSenior Lecturer and Researcher, Clinic of Reconstructive Dentistry, Center for Dental Medicine, University of Zurich, Zurich, Switzerland.

^bResearcher, Clinic of Reconstructive Dentistry, Center for Dental Medicine, University of Zurich, Zurich, Switzerland; Private practice, Perth, Australia.

^cDental Technician, Clinic of Reconstructive Dentistry, Center for Dental Medicine, University of Zurich, Zurich, Switzerland.

^dSenior Lecturer and Researcher, Clinic of Reconstructive Dentistry, Center for Dental Medicine, University of Zurich, Zurich, Switzerland.

^eUniversidad Autonoma de Chile, Chile.

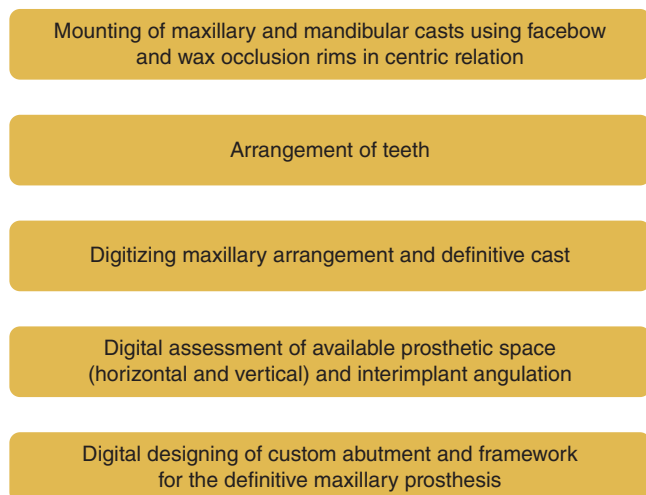


Figure 1. Flow-chart of clinical diagnostic steps for fabrication of custom abutment and metal framework.

maxillary implants, 3 Bicon implants and 1 implant with a significant labial angulation (Nobel Biocare).

Upon diagnostic planning and outlining of the definitive tooth position, it became evident that additional lip support and improved cleanability were necessary, and the maxillary and mandibular implants were restored with removable implant-supported overdentures. Angled 15-degree Brevis abutments, ball attachments, were selected for the maxillary Bicon implants. A custom

CAD-CAM LOCATOR attachment (T-L Custom; Tru Abutment Inc) was fabricated for the maxillary Nobel Biocare implant. Other angled attachments could have been selected, such as LOCATOR or Equator designs; however, only Bicon offered the ball attachment as a manufacturer's removable restorative solution at the time of restoration.

The mandibular reconstruction was restored with a removable implant-supported overdenture on 4 LOCATOR attachments. The following diagnostics steps were then carried out for the manufacturing of the custom attachment and framework for the removable implant-supported prosthesis (Fig. 1).

1. Make definitive implant impressions of the maxillary and mandibular arches with a polyether impression material (Permadyne; 3M ESPE) (Fig. 2).
2. Record the maxillomandibular relationship with wax rims and an intraoral gothic arch (CRS SET 10, Candulor AG).
3. Mount casts in a semi-adjustable articulator (Condylator; Candulor AG).
4. Perform the tooth arrangement to a lingualized occlusal scheme (Condylorform II NFC+; Candulor AG).
5. Digitize the maxillary and mandibular tooth arrangements and definitive cast using a dental scanner (3Shape D1000; 3Shape A/S) (Fig. 3).
6. Digitally design and subtractively manufacture a custom LOCATOR attachment with titanium alloy

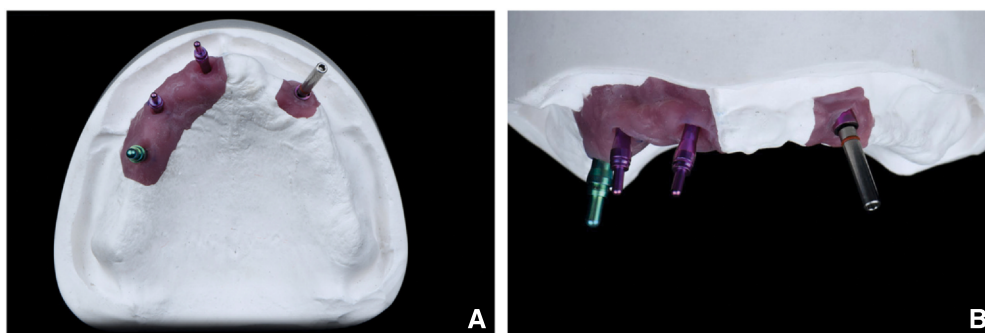


Figure 2. Maxillary definitive cast with divergent implant angulation. A, Occlusal view. B, frontal view.

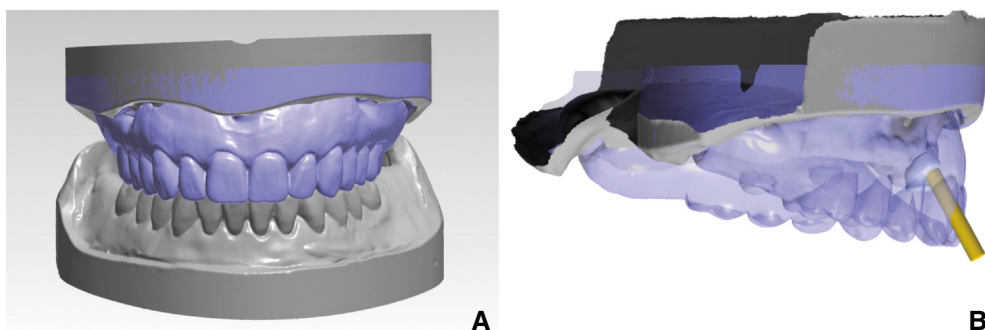


Figure 3. Tooth arrangement of denture. A, Frontal view. B, Lateral view showing implant angulation in relation to tooth arrangement.

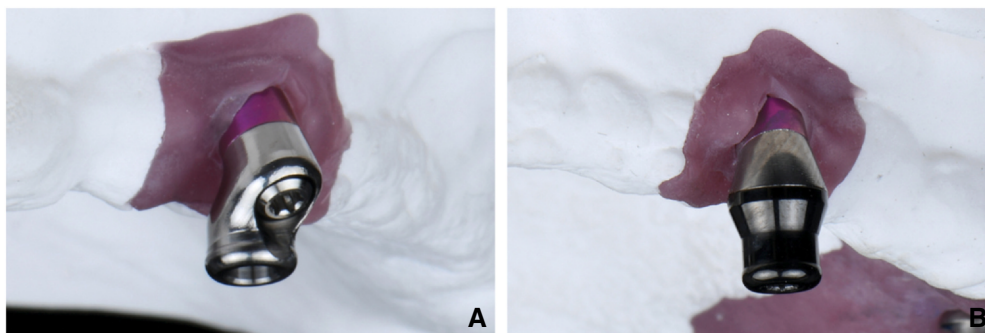


Figure 4. Angled resilient abutment solutions. A, T:Loc Abutment. B, 15-degree Angled Multi-Unit Abutment with Straumann Novaloc Attachment.

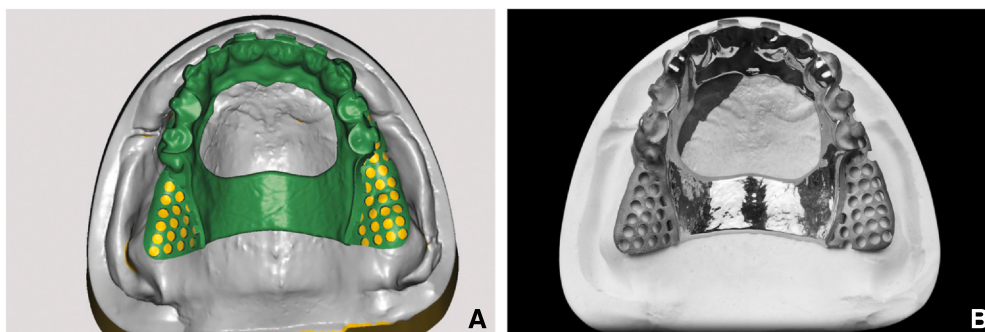


Figure 5. A, Computer-aided designed maxillary overdenture framework. B, Computer-aided manufactured direct metal laser sintering maxillary overdenture framework.



Figure 6. Autopolymerized resin maxillary and mandibular overdentures.

7. Digitally design and additively manufacture an overdenture framework (ProX DMP 100; 3D Systems) with an integrated custom attachment (Fig. 5).
8. Process the maxillary and mandibular overdenture with autopolymerizing acrylic resin (Blue Aesthetic; Candulor AG) (Fig. 6).
9. Deliver the resilient attachment together with the maxillary and mandibular overdentures (Fig. 7).

TI 6AL-4V (Titan; Zapp Precision Metals) by considering the available restorative space and inter-implant angulation (Fig. 4) (3Shape Dental System 2021 software; 3Shape A/S).

DISCUSSION

Fabricating a custom resilient attachment to support an implant overdenture involves expertise in both analog

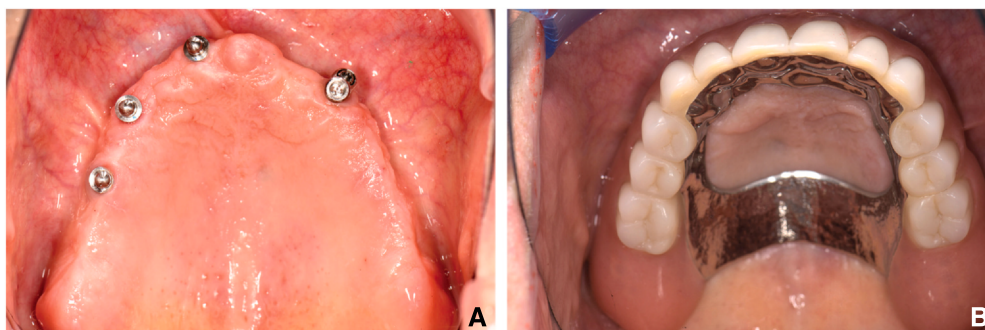


Figure 7. A, Insertion of resilient abutments; angled Brevis abutments and custom T-L Custom Abutment. B, Occlusal view of maxillary overdenture.

and digital workflows. Currently, evidence-based clinical guidelines for selecting LOCATOR attachments for implants of various heights and designs is lacking. The success of an overdenture depends on the selection of the attachment-related factors tailored to the clinical situation. For this patient, emphasis was placed on the angulation of existing implants in relation to restorative space, buccal contour, cost-effectiveness, and cleansability.

The significant labial angulations and superficial placement of the implants limited esthetic restorative options. The extensions and contours of the maxillary denture and alternatives to address the angulation meant encroaching on minimal material thicknesses or incurring extra costs for additional abutments and precision attachments (such as bar or multi-unit abutment). Using an angled LOCATOR attachment on the significantly misaligned implant would not have achieved the required parallelism between the abutments without compromising the thickness of the acrylic resin. Furthermore, utilizing a custom resilient attachment as opposed to an angled stock angled resilient attachment, allowed most of the bulk to be located palatally, preserving esthetics and positioning the attachment system over the ridge in the denture bearing area. Resilient attachments were chosen to avoid splinting significantly angled and differing implant systems, providing a cost-effective option.

Incorporating CAD-CAM processes into a prosthesis streamlined the fabrication phases. The exact dimensions and angulations of all proposed attachments and a CAM framework were tailored specifically for the maxillary arch, adding rigidity to the implant-supported prosthesis to prevent potential denture base fracturing. The design of the custom resilient attachment can be predetermined to ensure adequate placement of the retentive element in relation to gingival tissues while facilitating cleansability, and retrievability for maintenance.

Maintenance of resilient attachments, particularly replacing the rubber O rings or nylon inserts, is commonly required.^{7,8} To reduce frequent replacement, a removable prosthesis must be well supported by the mucosa independent of the resilient attachment.⁸ Furthermore, it is important to achieve minimal divergence between the abutments to avoid excessive wear.^{1,2}

Despite the use of digital technologies in overdenture fabrication, certain issues still need to be addressed conventionally. This includes transferring the resin teeth to the metal framework, which requires accurate transfer using a silicone guide. Intraoral registration of the

custom attachment and fixation of the matrices in the overdenture should occur during insertion by using adequate block out during matrix fixation to prevent displacement during prosthesis removal.

SUMMARY

This custom resilient attachment can serve when splinted options or multi-unit abutments with LOCATOR attachments or angled LOCATOR attachments are not suitable.

PATIENT CONSENT

Informed patient consent has been obtained.

REFERENCES

1. Weheda AH, Rady NA, Fahmy MH, Abdel AA. Clinical evaluation of splinted vs unsplinted short implants stability retaining mandibular overdentures. *Alex Dent J*. 2022;47:89–94.
2. Alqutaibi AY, Elawady DMA. Implant splinting in mandibular overdentures: A systematic review with meta-analysis of randomized clinical trials. *Quintessence Int*. 2020;51:294–302.
3. Di Francesco F, De Marco G, Capcha EB, et al. Patient satisfaction and survival of maxillary overdentures supported by four or six splinted implants: a systematic review with meta-analysis. *BMC Oral Health*. 2021;21:247.
4. Bouhy A, Rompen E, Lamy M, Legros C, Lecloux G, Lambert F. Maxillary implant overdenture retained by four unsplinted attachments and opposed by a natural or fixed dentition: One-year clinical outcomes. *Clin Oral Implants Res*. 2020;31:747–767.
5. Müller F, Srinivasan M, Krause KH, Schimmel M. Periodontitis and peri-implantitis in elderly people experiencing institutional and hospital confinement. *Periodontol 2000*. 2022;90:138–145.
6. Elsyad MA, Khairallah AS, Shawky AF. Changes in the edentulous maxilla with ball and telescopic attachments of implant-retained mandibular overdentures: A 4-year retrospective study. *Quintessence Int*. 2013;44:487–495.
7. Payne AG, Walton TR, Walton JN, Solomons YF. The outcome of implant overdentures from a prosthodontic perspective: Proposal for a classification protocol. *Int J Prosthodont*. 2001;14:27–32.
8. Osman RB, Payne AG, Ma S. Prosthodontic maintenance of maxillary implant overdentures: A systematic literature review. *Int J Prosthodont*. 2012;25:381–391.
9. Duhn C, Thalji G, Al-Tarwaneh S, Cooper LF. A digital approach to robust and esthetic implant overdenture construction. *J Esthet Restor Dent*. 2021;33:118–126.

Corresponding author:

Dr Franz J. Strauss
Clinic of Reconstructive Dentistry
Center for Dental Medicine
University of Zurich
Plattenstrasse 11
Zurich 8032
SWITZERLAND
Email: franz.strauss@zzm.uzh.ch

Copyright © 2024 The Authors. Published by Elsevier Inc. on behalf of the Editorial Council of *The Journal of Prosthetic Dentistry*. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>). <https://doi.org/10.1016/j.prosdent.2024.07.047>