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Case Report

Case Report: Combining Conventional and Digital Workflow for the Implant-Prosthetic Rehabilitation in a Partially Edentulous Patient

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Abstract

The lack of traceable structures and the smooth surfaces of long free end saddles in partially edentulous patients, may introduce errors in the stitching of images during intraoral scanning. These errors may in turn affect the accuracy of centric relation or maximum intercuspation registration. The aim of this study is to present a method of reducing the errors in the registration of maxillomandibular relationships in partially edentulous patients when intraoral scanning is used.

A 65-year-old woman with a Kennedy class I maxillary edentulism was restored by placing four implants in the upper posterior area. After osseointegration, a digital impression of the four implants was made in order to manufacture two screw-retained implant bridges. A screw-retained baseplate was conventionally fabricated for the registration of centric relation. The digital impression was taken with an intraoral digital scanner (3Shape Trios3, Copenhagen, Denmark). The baseplate with occlusal rims was scanned and used to transfer the interocclusal registration digitally. Digitally designed 3D printed prototypes contributed to the intraoral check of occlusion, contact points with the adjacent teeth, emergence profile, esthetic and phonetic outcome. Then, they were scanned and used to digitally design the final restoration. The final milled monolithic zirconia restorations were cemented on prefabricated Titanium base abutments and screwed in the implants at 35 Nt/mm.

The presented conventional-digital workflow constitutes an alternative to the conventional implant-prosthetic protocol providing a time effective outcome without complications.

The prototypes allow the clinician to simultaneously verify the accuracy of the digital impressions and check the prosthetic parameters in a single visit, reducing clinical and laboratory time. The delivery of the final prostheses was carried without difficulties and with minimal adjustments. Moreover, this workflow facilitates the communication of the dental team both with the dental technician and with the patient.

Keywords: *Centric Relation; Workflow; Zirconium Oxide; Printing; Digital*

Abbreviations

CAD/CAM: Computer Aided Designed/Computer Aided Manufactured; IOS: Intraoral Scanner; OVD: Vertical Dimension of Occlusion; CR: Centric Relation; Ti: Titanium; VIR: Virtual Interocclusal Relation

Introduction

The use of computer aided-designed and computer aided-manufacturing (CAD/CAM) technologies in Prosthetic dentistry is steadily increasing in the clinical practice. Advances in CAD/CAM workflows lead to milled and 3D printed restorations with precise fit since certain physical deficiencies of the conventional technique are limited, such as the dimensional changes of impression materials, the expansion of dental stone, and human errors related to fabrication of the final restoration [1,2]. Additionally, the digital impressions can be stored and processed in a digital environment, improving efficiency and reducing chairside and laboratory time as well as cost [3,4].

Significant efforts are made in order to examine the trueness and precision of several intraoral scanners while some studies investigate the accuracy of digitally transferred interocclusal records in partial and complete edentulism [5-8]. Studies revealed that the trueness and precision of the IOSs are lower for the full arch than in short-span areas due to the influences of the joints on errors during the stitching process when images overlap over a curved span [9]. Trueness and precision are also decreased while increasing the distance between the implant scan bodies [10]. The lack of traceable structures and the smooth surfaces of long free end saddles in partially edentulous patients, may introduce errors in the stitching of images during intraoral scanning. These errors may in turn affect the accuracy of centric relation or maximum intercuspation registration. A recent study found that the trueness and precision of intraoral scanning were improved if an artificial landmark in the long edentulous area was used [11], while another study states that the use of auxiliary geometric structures can enhance the outcomes of digital impressions of the edentulous maxilla [12].

Digital Rapid Prototyping technique in Implant Prosthodontics is a type of CAM technique in which milled or printed fabrications are manufactured (CAD technique) and cemented on prefabricated titanium bases. These prostheses verify the implant position intraorally and provide all the relevant information of the definitive final restoration, such as esthetics, contours, contact points and the maxillomandibular relationship [13-15]. With the aim of developing predictable protocols to transfer the interocclusal relationship digitally, different techniques have been published. The purpose of this report is to present a method for implant rehabilitation in partial edentulism when intraoral scanning is used reducing the errors in the registration of maxillomandibular relationship.

Case Report

A 65-year-old woman with a Kennedy class I maxillary edentulism was restored by placing four implants (Straumann AG, Switzerland) in the upper posterior area. The upper anterior and all the lower teeth had been restored conventionally with PFM restorations in the centric relation (CR) at the correct vertical dimension of occlusion (OVD) (Figure 1). After the appropriate healing period of six months, a conventional open tray polyvinylsiloxane impression (Hydrorise, Zhermack, Italy) of two implants was made (Figure 2 and 3). The working cast was fabricated with the double pouring technique and low expansion type IV stone. A baseplate screw-retained on two implants was conventionally fabricated for the registration of centric relation (Figure 4). During the next visit, the baseplate was eventually screwed to one implant intraorally using the incorporated impression copying verified by a periapical radiograph (Figure 5). The occlusal rims were shaped to record the appropriate OVD (Figure 6).

Figure 1: *Initial situation, maxillary and mandibular teeth restored with PFM in CR.*

Figure 2: *Maxillary implants, impression copings screwed to #15,17.*

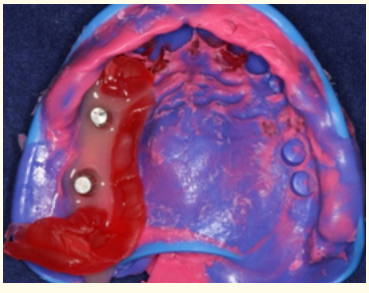

Figure 3: *Conventional PVS impression of #15,17 implants.*

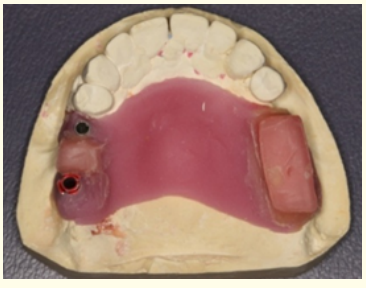

Figure 4: *Baseplate with occlusal rims, screw-retained to #17, using an incorporated impression coping.*

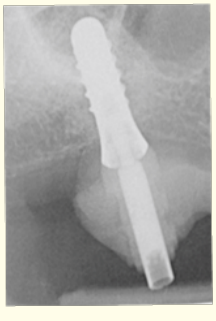

Figure 5: *Xray verification of the baseplate fit.*

Figure 6: *Maxillary "Prepreparation scan" with screwed occlusal baseplate.*

The digital impression was taken with an intraoral digital scanner (Trios3, 3Shape, Copenhagen, Denmark). The emergence profile of the implants in the regions of interest was scanned. Four standardized scan bodies (Scanbody with RN Platform, Straumann) were secured to the implants and an implant-level digital impression of the upper jaw was taken (Figure 8). The second scan included the opposing mandibular dentition. The registered maxillary baseplate was screwed to the implant and was used to perform a stable bite scan (Figure 7 and 9). The master cast obtained was a virtual model in which the restoration was designed digitally.

Figure 7: *Maxillary "Prepreparation scan" with screwed occlusal baseplate.*

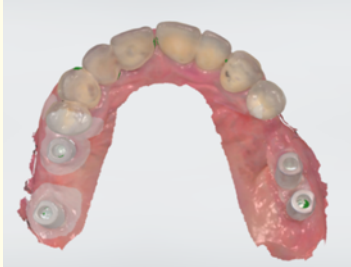

Figure 8: *Final maxillary scan.*

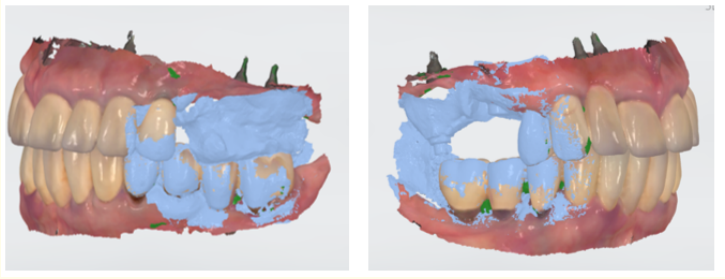

Figure 9: *Right and left bite scans: CR scan with the use of screw-retained baseplate. "Prepreparation scan" imported to the "Bite scan".*

As in the conventional workflow, it is essential to use a prototype to check four basic parameters (the implant position, the esthetic and occlusal parameters, and the emergence profile) to avoid inaccuracies, optimize esthetic and functional factors, and reduce treatment time. Resin prototypes were digitally designed, printed and cemented to prefabricated Ti base abutments (RN Variobase, Straumann) with resin cement (Nexus, Kerr). The two prototype prostheses were evaluated clinically. Passive fit of the Ti-base abutments was checked and the implant positions were verified by periapical radiographs. Minimal occlusal adjustments were made using articulating paper (AccuFilm II; Parkell Inc) and shimstock foil (GMH; Hanel Medizinal). Pontics and contours were slightly corrected with flowable composite resin. After checking phonetics, the prototypes were scanned and replicated for the CAD/CAM fabrication of the definitive milled monolithic zirconia prostheses (Figure 10). The delivery of the final prostheses was carried out without the need for adjustments (Figure 11). The restorations were screwed to the implants (35 N/cm torque) and composite fillings were placed on screw channels.

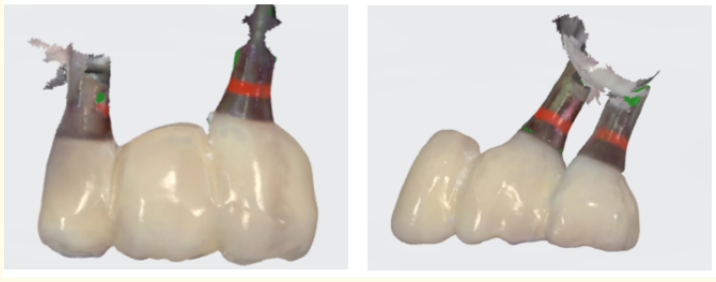

Figure 10: *3D printed prototypes of the final restoration for the check of occlusal contacts, emergence profile, esthetic and phonetic outcome. After adjustments, they were replicated at the final restorations.*

Figure 11: *Final monolithic zirconia bridges.*

Discussion

The accuracy of IOS and CAD/CAM restorations has been evaluated, however, research on techniques improving accuracy of VIR (Virtual Interocclusal Relation) is still under investigation [12,13]. It has been demonstrated that scans of long edentulous areas in partial edentulism are not aligned in the correct relation to each other [16]. Unilateral and bilateral extended edentulous spans with 3 or more missing posterior teeth and the extended edentulous span in the anterior region all affect the accuracy of VIRs. The use of a complete digital workflow in clinical scenarios with extended edentulous space might not be a predictable practice [7]. Accurately transferring the interocclusal relationship into the CAD/CAM software program is essential for providing clinically acceptable restorations decreasing the necessity for chairside occlusal adjustment. Most IOSs require bilateral VIR registration to locate the relative position of maxillary and mandibular digital casts [17]. However, when teeth or landmarks are absent, the process of occlusal alignment for digital casts becomes problematic [18].

The presented workflow was described to exploit the benefits of CAD/CAM developments for the manufacture of two screw-retained implant bridges without physical final impression and master cast. Nevertheless, jaw relationship in partial edentulism cannot be scanned easily and accurately and requires the presence of a physical landmark. Screw-retained occlusion rims conventionally fabricated provide a stable bite registration; the retention decreases the risk of unwanted movement, leading to an incorrect bite registration. Although silicone records could be used to register the interocclusal relationship, higher material elasticity responsible for distortions constitutes a significant disadvantage.

Conclusion

The presented conventional-digital workflow, despite the extra stages it requires, becomes an alternative to the conventional implant-prosthetic protocol, leading to a more predictable jaw relationship recording. In this case, the prototypes allowed the clinician to simultaneously verify the accuracy of the digital impressions and check the prosthetic parameters in a single visit, reducing clinical and laboratory time. Also, this workflow facilitates the communication of the dental team both with the dental technician and with the patient. However, more evidence from clinical trials is required to evaluate techniques for transferring predictably and accurately the maxillomandibular relationship in the digital environment.

Conflicts of Interest

The authors declare no conflict of interest.

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