Clinical Dentistry Reviewed (2021) 5:12
https://doi.org/10.1007/s41894-021-00102-5

TECHNIQUES

# Full mouth rehabilitation using chairside CAD/CAM

**Eva Raposo Morales[1] · Sanchez Sergio[1] · Elias M. Chatah[1] · Geraldine Weinstein[1]**

Received: 18 March 2021 / Accepted: 14 June 2021 / Published online: 3 July 2021


## Abstract

Computer-aided design and computer-aided manufacturing (CAD/CAM) systems have historically proven to produce high-quality single-tooth restorations. In recent years, advancements in the scope of scanning technologies in the dental profession have provided a potential platform for complex digital workflows involving complete mouth rehabilitation. This article details the use of both analog and digital methods for reestablishing occlusal function and esthetics in a clinical case involving extreme tooth wear and loss of vertical dimension. The use of both methods was necessary in this case to achieve optimal occlusion, an esthetic result, and a harmonious dentition.

**Keywords** Digital full mouth rehabilitation · Bruxism · CAD/CAM · Digital custom abutment · VDO

## Quick reference/description

Bruxism is a common cause of severe tooth wear. The American Academy of Orofacial Pain defines bruxism as *"diurnal or nocturnal parafunctional activity including clenching, bracing, gnashing, and grinding of the teeth"*.

The glossary of prosthodontic terms (GPT-9) defines bruxism as follows: *"1. the parafunctional grinding of teeth; 2. an oral habit consisting of involuntary rhythmic or spasmodic nonfunctional gnashing, grinding, or clenching of teeth, in other than chewing movements of the mandible, which may lead to occlusal trauma"*.

Risk factors for bruxism include stress and anxiety, behavioral disorders, excessive consumption of tobacco products, alcohol and caffeine, sleep disorders, ADHD, and dental malocclusion. Management modalities for bruxism include physical therapy and muscle relaxation, stress management, botulinum toxin injections, and oral appliances. In conjunction with these modalities, the restoration of the worn

✉ Eva Raposo Morales
eva.raposomorales@gmail.com

[1] University of Connecticut School of Dental Medicine, Farmington, USA

**Fig. 1** Erosion and attrition of both maxillary and mandibular teeth

**Fig. 2** Loss of VDO due to missing and severely worn posterior teeth

dentition is indicated in select patients: this may indicate full mouth rehabilitation, following which oral appliances are prescribed to protect the newly rehabilitated oral cavity and reduce the possibility of relapse.

Full mouth rehabilitation is indicated for patients with severely worn dentition, which might be accompanied by a loss of vertical dimension of occlusion (VDO). Traditional full mouth rehabilitation requires several chairside appointments. Case success correlates with the dentist's skills, laboratory technician skills, patient cooperation with the treatment plan, and compliance.

Full mouth rehabilitation was indicated in this case for the following reasons:

- Severe bruxism, attrition and erosion of the dentition (Fig. 1)
- Masticatory dysfunction and loss of VDO as a result of attrition and missing teeth (Fig. 2)
- Esthetic concerns: patient expressed concern with the lack of tooth display when smiling
- Several teeth requiring full coverage restorations as a result of the loss of tooth structure corresponding to ACE Classification IV,V and VI. (Figs. 1, 2, and 3)
- Several teeth requiring extractions

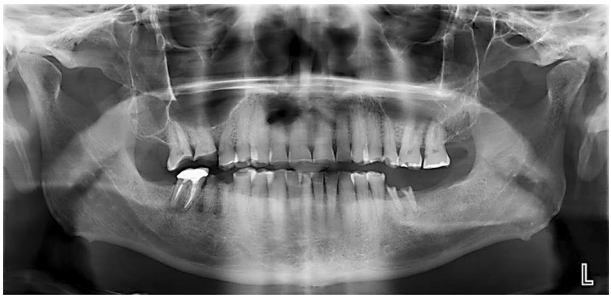

**Fig. 3** Panoramic radiograph shows evidence of extreme loss of tooth structure, re-infection of endodontically treated tooth, and retained roots

Below we will describe the use of Dentsply Sirona's Primescan®, software version 5.1, in combination with more traditional analog workflows to complete this case. The digital workflow includes restorations for individual teeth, implant planning, fabrication of implant custom abutments, and implant restorations.

A complete examination was performed. Diagnoses were as follows:

- caries;
- retained roots;
- re-infected root-treated tooth;
- missing teeth;
- loss of VDO (due to lack of posterior support);
- bruxism and extreme anterior and posterior tooth wear;
- lack of esthetics, tooth display upon smiling.

The treatment plan for this patient included: hygiene, restorative, teeth extraction, replacement of missing/extracted teeth with implant placement, bone augmentation and a sinus lift, teeth-supported and implant-supported crowns, patient education, and occlusal guard. Space analysis was an essential step in this case.

## Materials/instruments

- Phase 1 of the treatment plan was completed.
- The occlusal analysis was performed with stone casts mounted in centric relation on a semi-adjustable articulator.
- Full mouth wax-up was achieved with stone casts at the reestablished VDO, which was increased by 5 mm at the incisal tip of the articulator.
- CBCT and digital planning (coDiagnostiX®, Dental Wings software) for implant placement.
- Dentsply Sirona Primescan® intraoral scanner (CAD/CAM system).

- Management of bruxism: patient education, stress reduction, diet review, use of a mouthguard. No TMJ concerns.

## Procedures

### Diagnostic phase

Pretreatment photos were obtained. Frontal photo is shown below.

The physiologic rest position of the mandible when the patient is resting in an upright position was 9 cm from the tip of the nose to the chin during baseline. The patient presented an increased freeway space as a consequence of bruxism. Freeway space before restorations was 7 mm and 2 mm after restorations. VDO was increased within the vertical dimension of rest to rehabilitate the extremely worn dentition of the patient that originally presented inadequate space for restorations.

Alteration of VDO was initiated from centric relation (CR). Centric relation was recorded by de-programming posterior teeth and jaw manipulation procedures. This was transferred and mounted in Artex® semi-adjustable articulator.

Increasing the VDO 5 mm allowed restoration of the worn dentition without encroaching the vertical dimension of rest (VDR) and gaining enough space for restorative material (zirconia). Increasing the VDO by 5 mm was enough to provide the esthetic result (exposure of upper teeth) and the functional occlusal scheme desired, mutually protected occlusion anterior–posteriorly and canine protected in lateral movements.

Recording patient´s centric relation was the reference relation taken through mandibular manipulation and several interocclusal wax records were used for it before a change in the VDO. No pantographic tracings were performed to measure the accuracy of the mandibular movements in three planes during this process. Study models were mounted in CR in a traditional semi-adjustable articulator (Fig. 4).

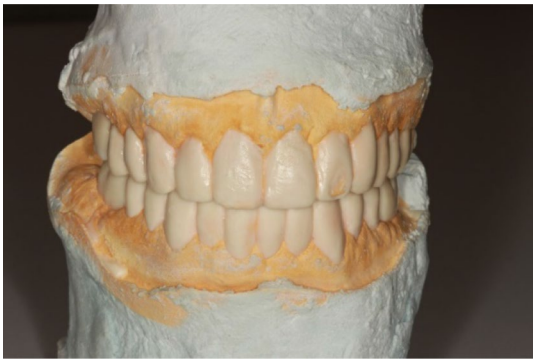

**Fig. 4** Traditional wax-up

## Restorative phase

- Direct composite bonding was performed on teeth under rubber dam: the teeth were selectively etched for 15 s with 37% phosphoric acid. Scotchbond® was then applied for 20 s following the manufacture's instructions, thinned with air, then light-cured. Nano-filled composite resin (Filtek Supreme®) was used to fill undercuts and rebuild the tooth structure one by one.
- Following crown preparations, optical impressions were obtained using the Cerec Primescan® intraoral scanner, software version 5.0. Biocopy mode and the traditional wax-up were used as the basis for the fabrication of the temporary restorations (Fig. 5).
- For temporization, we used PMMA (Telio®) blocks: this process was performed in 2 days, starting with the posterior teeth to achieve a stable occlusion, progressing to anterior teeth. Interim PMMA (Telio®) crowns were polished with a pumice stone powder to enhance esthetics.The Biocopy mode in Cerec® produced provisional esthetic restorations which were amenable to changing the VDO (Fig. 6).

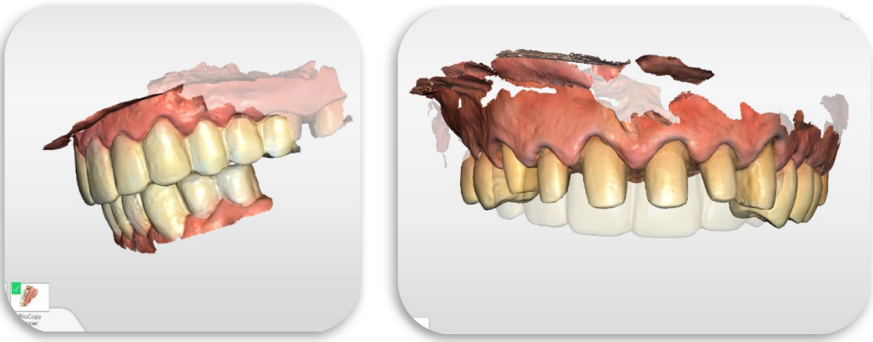

**Fig. 5** Biocopy design using the Cerec® 5.0 software

**Fig. 6** Interim crowns

To reestablish adequate VDO, deprogram the patient's occlusion and muscles, and obtain regular feedback from the patient, provisional restorations remained in place for a period of 5 months to achieve adaptation to the neuromuscular system.

Following VDO establishment, the adaptive response was evaluated during the provisionalization phase for 5 months. During the provisionalization phase, adjustments to the occlusion were made to avoid occlusal interferences. The adjustments made, the establishment of VDO and occlusal morphology, proved to be within the range of patient´s neuromuscular adaptation. Thus, permanent restorations were made following the occlusal scheme of temporary restorations with minor adjustments.

A hard acrylic mouth guard was fabricated for the patient at the end of the rehabilitation treatment.

## Surgical phase

- Implant planning and placement were performed during the temporization period: Cerec® intraoral scanner was utilized; this scan was used to create a digital wax-up. This information and the CBCT of the patient were combined utilizing the coDiagnostiX® implant software for implant planning. A surgical guide was 3D printed for fully guided implant surgery. For non-restorable molars, fully guided Sweden & Martina® implants of 5 mm diameter and 8.5 mm length was placed in tooth position number 3 and 10 mm in length were placed for teeth positions number 19, and 30.
- In tooth position number 3, in preparation for the planned implant, maxillary sinus elevation was performed using the indirect approach with the "Magnetic Mallet" from Sweden & Martina®—the purpose of this procedure is to increase the amount of bone around the planned implant (Fig. 7). The implant placement was performed during the same surgery after sinus lift atraumatic procedure. The implant was covered after the surgery and it was uncovered 5 months later using a stock healing abutment. Figure 8 shows the result of this procedure 5 months post-op.
- Following the manufacturer's recommendations, implant sites were prepared with a continual sequence of sized drills, and implants were torqued per the man-

**Fig. 7** Right maxillary sinus lift with magnetic mallet

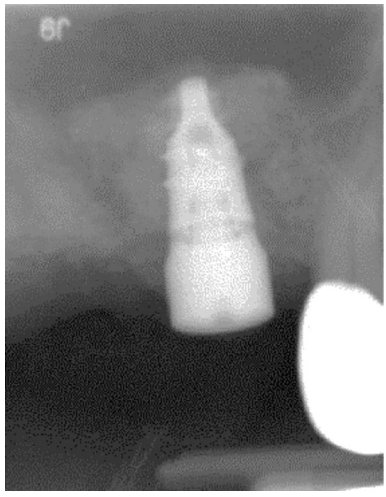

**Fig. 8** Maxillary sinus lift result 5 months post-op

ufacturer's reference. The patient was given post-operative instructions and was prescribed Amoxicillin 500 mg every 8 h for 7 days and Ibuprofen 600 mg TID PRN pain. A review of the literature showed a success rate of 92% when no anti-

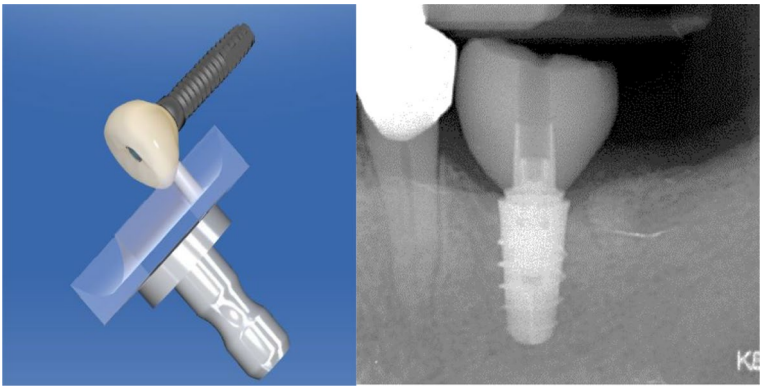

**Fig. 9** Cerec® 5.0 Custom healing abutment was designed to create a suitable emergence profile and a final screw-retained eMax crown

biotics were used for implant surgery versus 97% when post-operative antibiotics were used (5).

– Following implant placement, scanning was performed using the prescribed scan body. Custom healing abutments were fabricated with milled PMMA (Telio Ivoclar Vivadent®) block A2 A16 (S) using Cerec® and guiding soft-tissue emergence profile at an early stage (Fig. 9).

## Final restorations

– Following 5 months of temporization, follow-up and minor occlusion adjustments, new digital scans were taken using Cerec Primescan®. Cerec Primescan® was user-friendly, produced accurate impressions, and reduced chair time.

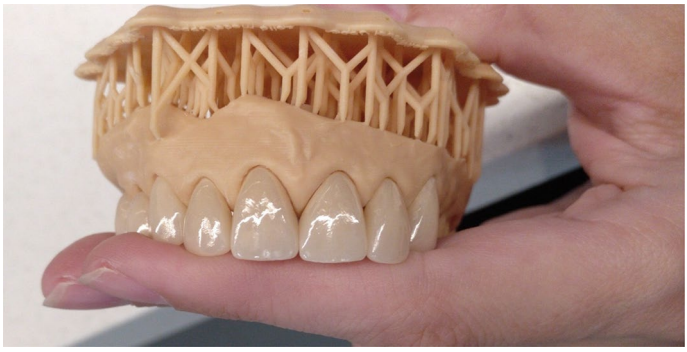

**Fig. 10** Polished multi-layered Zirconia Katana® crowns on 3D printed model

- Custom milled abutments, fabricated from PMMA blocks, cemented on a Ti-base resulted in an easy and efficient way to shape the emergence profile around implants at an early stage after surgery.
- Multi-layered Zirconia (Katana®) blocks were used to create the permanent crowns. Following the same process, optical impressions were taken with Cerec® Primescan and temporary crowns were scanned in the patient´s mouth under the biocopy mode: each side was scanned separately to preserve the newly established VDO. The biocopy design was optimized using the software functions. Crowns were later polished (no stain or glaze was necessary).
- Models were 3D printed with Printer FormLabs2 to check the fitting of the final restorations (Fig. 10).
- We followed the manufacturer's instructions when delivering the multi-layered Zirconia (Katana®) crowns: the crowns were cleaned with Ivoclean; prepared teeth were isolated with a rubber dam, etched with 37% orthophosphoric acid, and rinsed and air-dried. Bonding was then applied, thinned with air then light-cured. MDP monomer-based resin was used to cement the crowns. Excess cement was removed, occlusion was checked and adjusted, and the crowns were polished.

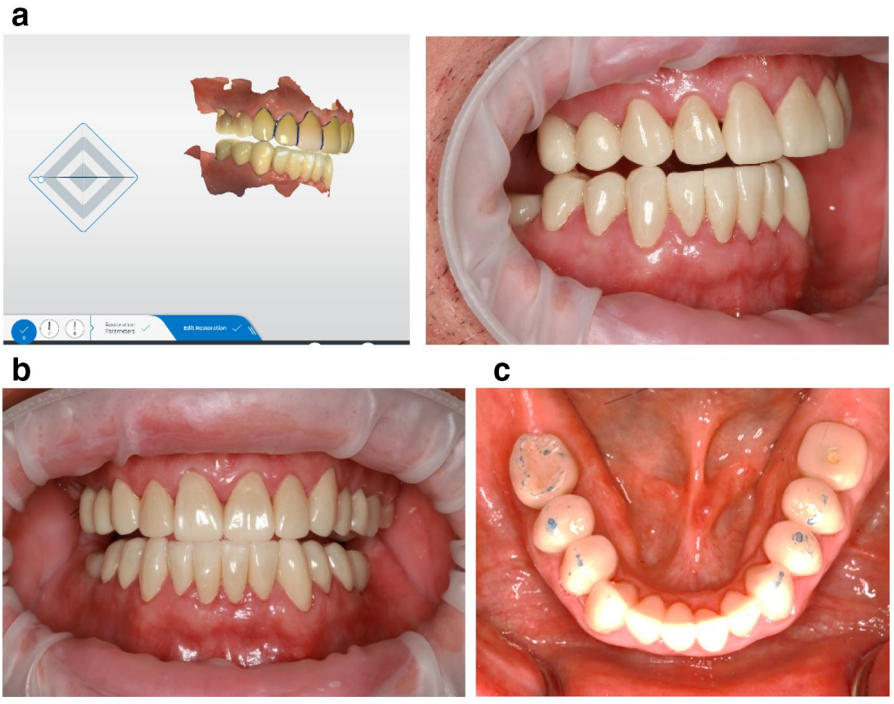


**Fig. 11** **a** Canine guidance of permanent crowns shown on Cerec® 5.0 software and intraorally during lateral excursion. **b** Anterior guidance of permanent crowns during protrusive movement. **c** Balanced occlusal scheme of final restorations. *(please note that eMax screw-retained crown #19 and Telio custom abutment #30)*

– The occlusal scheme was as follows: canine guidance and anterior guidance—this will ensure long-term success from a prosthodontic, periodontic, and esthetic perspective (Fig. 11a–c).

### Final result

The photographs below illustrate the final result, which addressed the patient's chief complaint of restoring his smile with more tooth display when smiling and reversing tooth wear. A mouth guard was fabricated (Michigan type), and the importance of compliance was reinforced along with the importance of attending dental appointments regularly.

The patient was counseled on parafunctional and dietary habits and their impact on the long-term success of the restorations. The patient was pleased with the final result.

Smile at Presentation

Smile with permanent crowns (implant crown # 3 not delivered at this time)

## Pitfalls/complications

- Katana® (Zirconia) blocks were unavailable for the fabrication of screw-retained implant crowns.
- Restoring the VDO proved to be a challenge due to a lack of space for the restorations.
- Preserving tooth structure was also a challenge due to the extent of bruxism.
- Financial: acquisition of the CAD/CAM system is high.
- Knowledge of the software is needed to utilize all of its features. An analog wax-up was utilized in this case due to the time consuming design process for a full mouth case if done digitally. Support with the use of CAD/CAM software required collaboration with the company representative.

This case required a considerable change in VDO. CAD/CAM technology provided a reliable, predictable, and economically viable workflow for the accurate fabrication of full mouth restorations. The protocol described above reduced chair

time for the patient and the laboratory, minimizing the dental team's financial costs. It also improved the patient–doctor communication and relationship. The patient's overall enthusiasm and compliance played an essential role in the final success of this case.

State of the art technology, specifically dental scanning technology in this case made digital impressions and milling process a more accurate and faster tool than traditional methods. The scanner used processes 50.000 images per second and the depth scan is up to 20 mm. The design flow and process seemed intuitive although some guidance was required.

Traditional impressions can be challenging for full mouth rehabilitations as all margins need to be captured precisely in one impression: at times this requires several attempts. Digital impressions allow the clinician to rescan the site without the need to retake an impression.

Milling provisional crowns in the office offers an advantage by saving chair time and providing stable and functional provisionals for the patient that can reduce emergency appointments. In addition, the use of accurate digital provisional restorations, reduces the time spent creating the final restorations, as the provisionals can be replicated in Zirconia.

**Acknowledgements** We would like to thank Frank Deluca, Cerec® representative, for providing the Primescan®, dedicating his time to this case, and being a valuable resource throughout this case. We would also like to thank our patient.

## Further reading

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