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CAD/CAM

the international magazine of digital dentistry

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_technique

A convenient cement for CAD block inlays

_opinion

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CAD/CAM in dentistry

Dr. Gordon J. Christensen, top, and Dr. Paul L. Child Jr.

_The concept of CAD/CAM has roots in antiquity. However, in the 1950s, CAD/CAM technology started to have some of the characteristics of what we now know as CAD/CAM. In the 1970s, computer drafting was popular, and by the 1980s, engineering applications of the concept became useful. Currently, CAD/CAM is used in almost every industry with great success.

Dentistry has been relatively slow to adapt to the concept, even though other industries have transformed most of their manufacturing processes to CAD/CAM because of its improved efficiency, repeatability and predictability. It was only about 25 years ago the CAD/CAM concept for milling restorations was introduced into dentistry with devices that were time consuming and difficult to manipulate. Many thought the concept would never replace the time honored "lost wax" casting technique and the commonly used direct restorative techniques.

_How wrong they were ...

Currently, CAD/CAM in dentistry is not only used, it is preferred by a growing and enthusiastic group of dental practitioners who have discovered its value and who have learned how to integrate the concept into mainstream dental practice. CAD/CAM in dentistry is beyond the phase of early adopters and those who buy everything new – it's now moving into the "early majority."

The dental CAD/CAM technologies now available, and the clinical results that are available to the profession and the patients they serve, would have seemed impossible only a few years ago. A realistic appraisal of some of them includes:

- After a conservative learning period, imaging and milling of crowns and onlays with accuracy and clinical longevity prove to be superior to conventional restorations.
- With experience, fabrication of inlays and veneers rival traditional techniques.
- Expanded use of competent, well-educated staff persons accomplishes much of the clinical procedure, allowing dentists to do other diverse techniques at the same time the restorations are being made.
- They provide patients a single-appointment, relatively simple procedure that is interesting and exciting to them while also being a practice builder for the practitioner.
- There is a new vista of communication between dentists, dental technologists and assistants as the "sky" is opened to the CAD/CAM concept.
- Although CAD/CAM was pioneered by CEREC, E4D and others are now providing proven alternatives in this growing area .
- Moving rapidly beyond just fixed restorations into a convergence of multiple disciplines in dentistry, CAD/CAM now includes implant dentistry, orthodontics, occlusion and surgery.

There is no question that dentistry has awakened to the CAD/CAM concept. It is providing unprecedented service to millions of patients and deserves the attention of practitioners. Our basic and clinical research over 20 years in Clinicians Report® (*www.cliniciansreport.org*; formerly CRA) validates its use and future potential for the profession.

Gordon J. Christensen, DDS, MSD, PhD
Paul L. Child Jr., DMD, CDT


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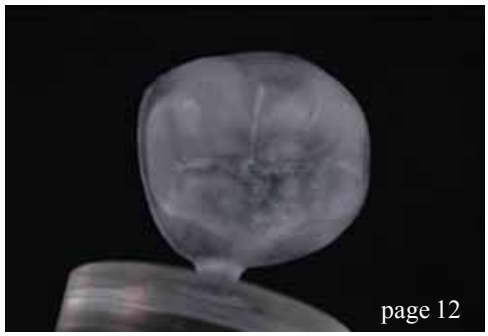
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EXPANDING THE DIFFERENCE

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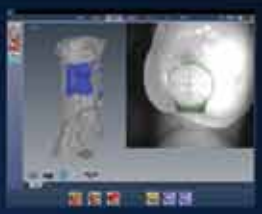

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DDX is a global web-enabled application that allows dental professionals such as laboratories and dentists to communicate more efficiently.

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Conservative dentistry achieved through a multi-disciplinary approach

Author_Thomas Colina, DMD

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Combining orthodontics and CAD/CAM technology to achieve conservatism for a rehabilitation case

_Complex treatment needs can necessitate oral rehabilitation of patients. Often these patients will require a multi-disciplinary approach to correct problems. When patients have significant concerns, such as severe malocclusions or destruction of dental tissue, oral rehabilitation can entail extensive treatment that may involve reconstructions.

To return the patient to optimal function, regain normal form and address possible concerns such as esthetics, an integrated approach that involves various disciplines needs to be taken. The challenge posed to a particular treatment plan may involve the treatment of many teeth and possibly the need to prepare a significant number of teeth and corresponding dental tissue.

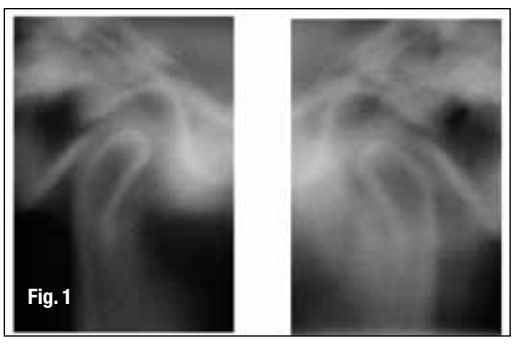

Fig. 1_Corrected lateral tomograms of the TMJ at maximum intercuspation. Note the posteriorly displaced condyles that have undergone morphological bending. (Photos/Provided by Dr. Thomas Colina)

Another challenge in reconstruction cases is the cost associated with the restoration of numerous teeth. Cost may be a factor for patients. There are often many options and approaches that can lead to the same successful treatment outcome. The variety of options can be at different ends of the spectrum. Diagnostic tools, including tomograms and the use of CAD/CAM systems, are useful in achieving complex treatment goals. This paper presents a treatment option that is an alternative to the reconstruction approach through the innovative application of multiple disciplines and current technology.

_Case presentation

A 31-year-old male patient presented with the chief complaint of his upper front teeth restorations breaking off a few months after being placed. He has had the front teeth restored numerous times with the same outcome. A comprehensive examination and records revealed the following findings.

_Medical history and functional concerns

There is a history of arthritis in the family. The patient experiences transient pain from his back, neck and shoulders. He has noted he clenches and grinds

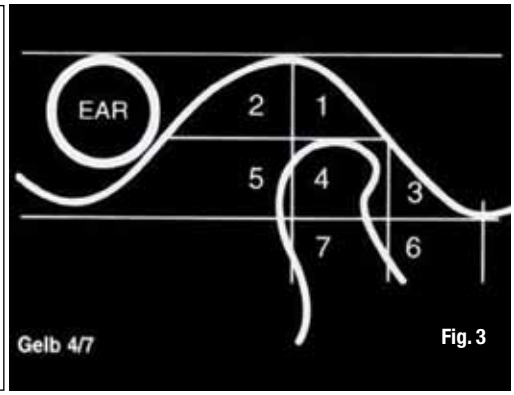

Fig. 2_Pretreatment photos.

Fig. 3_Gelb 4/7 physiologic position.

his teeth day and night. He was involved in a motor vehicle accident and sustained head trauma 12 years before his presentation to our office. Along with routine examination protocols, the temporomandibular joint (TMJ) was examined using a TMJ health questionnaire, range of motion examination, muscle palpation and TMJ imaging.

TMJ findings and symptoms were: normal maximum opening to 53 mm; no limitation in excursion; at opening, there is a 2 mm deviation to the left. There is a posterior slide from centric relation to maximum intercuspation. The patient noted cracking noises from the TMJ at opening and closing, and there has been occasional locking of the TMJ through the years. He has slight hearing loss and tinnitus.

As a routine for patients exhibiting TMJ dysfunction, a TMJ tomogram series was taken. Tomographic series was achieved by use of a CranexTome (Soredex, Tuusula, Finland). The CranexTome has a unique spiral tomography for cross-sectional images. Interpretation of hard tissue imaging study would include the evaluation of condylar and temporal component morphology and integrity of the bony articulating surfaces. The TMJ is assessed for signs of remodeling, degenerative joint disease or morphological variations affecting the TMJ, jaw and skull.

Condylar position in maximum intercuspation is evaluated. The diagnostic tools are used not only for initial assessment to attain a working and definitive diagnosis, but during and after treatment to assess attainment of the treatment objectives. The corrected lateral TMJ view taken at maximum intercuspation reveals a posteriorly displaced condyle and morphological bending of the condyles (Fig. 1). The joint vibration analysis (JVA Bioresearch International, Milwaukee, Wis.) is used to assess TMJ health for patients and yielded fairly normal vibrations of the TMJ.

_Skeletal pattern

Based on a cephalometric analysis, the patient presented with a Class I skeletal pattern with a slight retrognathic mandible.

_Occlusion

A visual examination and cast analysis revealed a Class II dental pattern with a deep overbite and tight overjet, fractured upper incisor restorations, slight crowding of the upper and lower arches, and severe worn dentition (especially the anterior teeth). The upper incisors were retroclined, and the upper and lower incisors had severe wear (Fig. 2).

There was generalized moderate wear on the posterior teeth. The patient presented with a posterior shift of 2 mm from centric relation to maximum intercuspation.

_Treatment options

The following treatment options were presented to the patient:

- *Reconstruction of the arches to achieve an idealized occlusion.* This first option would entail splint therapy and eventual reconstruction to achieve a stabilized occlusion. This approach will provide a stable occlusion and would entail restoration of numerous teeth — both anterior and posterior — to support the anticipated change in vertical dimension. The disadvantage to the approach is the introduction of artificial material in the mouth and the need for maintenance of the restorations. Of course, this approach also entails significant dental tissue reduction to provide partial and full coverage restorations to support the occlusal scheme.

In addition, although the treatment can be provided in a fairly short amount of time, the cost for the restorations can be significant for most patients.

- *Orthodontic approach to achieve the best possible occlusion and orthopedic alignment.* This approach provides for the patient an option to conserve dental structure, minimize the number of restorations to provide a stable and functional occlusion, and allows cost for the treatment to be more manageable. The disadvantage is the time required to achieve orthopedic and orthodontic correction.

Fig. 4_Debracket photos.

Fig. 5_Veneer post insert photos.

Fig. 4

Fig. 5

_Treatment plan details

Straight wire appliance treatment (SWA) was proposed to attain ideal inter- and intra-arch alignment augmented by a mandibular repositioning mechanics by way of posterior build-ups and elastics or a fixed orthotic or use of a Twin Force Appliance. This phase of treatment was anticipated to last 20 months. After the orthodontic treatment, restoration of the six anterior maxillary teeth with porcelain restorations would follow. The lower incisors will be evaluated for the need of restorations. The need for an upper bruxing appliance would also be evaluated after the completion of the restorations.

_Discussion of the treatment

The first phase of the treatment was the provision of orthodontic therapy using GAC Innovation C Self Ligating Bracket System. The Innovation C bracket system has a highly translucent porcelain structure and a rhodium coated clip, which provide superb esthetics as well as a high-torque component for the incisors of 17 degrees for the upper central and 10 degrees for the upper lateral incisors. One of the main goals for the treatment was the correction of the maxillary incisor torque. The retroclined upper incisors had contributed significantly to the severe wear of the anterior teeth and had resulted in an intercuspation that produced a posteriorly displaced condyle. The correction of the incisor torque brought about a natural repositioning of the mandible, which was a treatment goal for the patient. The JVA, which has been proven effective in discriminating joint vibrations to assess TMJ[1,2] conditions, was utilized to evaluate the TMJ during and after treatment. Anterior repositioning of the mandible has been described in the literature as a viable approach in the treatment of Class II malocclusions and TMJ dysfunction.

Woodside[3] and McNamara[4] describe a functional approach to the correction of the Class II malocclusion. Anterior repositioning therapy has had a history of more than 50 years. Gelb[5] referred to his repositioning appliance in 1959 and described the Gelb 4/7 position, which is currently accepted in the literature and recognized by many practitioners treating TMJ dysfunction to correlate with the physiologic position of the condyle in the fossa (Fig. 3). Several functional appliance designs and their efficacy of improving TMJ dysfunction through mandibular repositioning have been described in later literature.[6,7] Simmons[8] further describes the alleviation of symptoms after mandibular repositioning.

As noted, there was a natural anterior repositioning of the mandible upon removal of the centric interference in this patient, and appliance therapy was unnecessary. Posterior resin build-ups with Class II elastic therapy were sufficient to erupt the posterior teeth to achieve stability of the posterior segment. The condylar position was evaluated by use of progress tomograms and was supported and accompanied with the alleviation of TMJ related symptoms. To address concerns over the color of the teeth, the patient opted to whiten the teeth before the provision of the definitive restorations for the anterior teeth. Upon evaluation of the post-orthodontic occlusion, to provide an occlusion with anterior guidance at protrusion and canine guidance at lateral excursion, it was adequate to provide restorations for only the upper incisor (Figs. 4, 5). The upper incisors were prepared conservatively and restored with porcelain IPS e.max CAD lithium disilicate veneers milled with the chairside E4D Dentist CAD/CAM system (D4D Technologies, Richardson, Texas) (Figs. 6–8).

There are numerous systems that are currently available. Systems are available chairside or laboratory based. The E4D Dentist system allows the restorative dentist to have complete control of design and delivery of restorations. The system uses a laser capture to acquire a digital impression. The information is condensed, aided by computer, to an intuitive format that allows the restorative dentist to modify the design and send the design to a precise automated milling unit that uses robotic technology.


Fig. 6


Fig. 7


Fig. 8

The system essentially automates many of the more mechanical and labor intensive procedures, such as waxing, investing, burnout, casting and/or pressing involved in conventional fabrication of dental restorations.[9]

Lithium disilicate (IPS e.max) has the superior flexural strength of 360 MPa to 400 MPa, as compared to the strength of ceramic for PFM crowns, which has the strength of 80 MPa to 100 MPa; veneered zirconia, which has a flexural strength of 100 MPa; and leucite glass, which has the strength of approximately 150 MPa to 160 MPa. Lithium disilicate is a highly esthetic, high-strength material that can be conventionally cemented or adhesively bonded.[10] The pressable lithium disilicate is indicated for inlays, onlays, thin veneers, veneers, partial crowns, three-unit anterior bridges, three-unit premolar bridges, telescope primary crowns and implant restoration while the machinable lithium disilicate is indicated for all the previous applications except bridges.[11–14]

_Summary

Reconstructive treatment usually entails significant correction of malocclusion and the maxillomandibular relationship. Many patients requiring reconstruction commonly present with varying functional concerns, including TMJ dysfunction and associated symptoms. Technology, such as tomogram series and the use of JVA, could serve as standard equipment in the diagnosis and treatment of these patients as well as aid in objectively evaluating the TMJ condition during and after the treatment. The goal of any treatment is to provide the patient with good esthetics, comfort and long-term function. The innovative melding of disciplines and the use of current materials and technology can allow conservation of dental tissue that is irreversibly altered and removed using the traditional reconstructive approaches._

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Figs. 6, 7_ E4D veneer design for teeth #22, #21, #11 and #12. Conservative design achieved, made possible with post-orthodontic idealized occlusion.

Fig. 8_ Reflected frontal closeup.

_contact CAD/CAM

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