DIGITAL DUPLICATION OF THE ANTERIOR GUIDANCE
BY JOHN C. CRANHAM, D.D.S.

Few things in dentistry are as rewarding as restoring someone’s smile back to optimum oral health. One that provides the patient with the esthetic result they were counting on, as well as a functional and biomechanical result that will serve the patient for years to come. While ceramics and restorative materials have been evolving at a very rapid rate, until recently the way we communicated critical contours to the laboratory has not. The goal of this article is to review the functional contours that must be communicated and to outline a more reliable way to provide the dental lab with the critical information required.

Occlusal Goals

1.) Equal intensity stops in centric relation - The first tenant of any stable occlusion is for all the teeth in one arch to hit the teeth in the opposing arch at approximately the same time. Additionally, it is ideal if this can happen when the joint is at the most anterior-superior position in the glenoid fossa (centric relation). This will create a reproducible position, and one where the masticatory muscles will be the most harmonious. Equal intensity stops will balance whatever the force the patient can generate over the entire dentition, as well as create vertical stability of each tooth.

2.) Posterior teeth the patient can’t rub (non-interfering posterior teeth) - One of the most important goals of any healthy occlusal scheme is to create a situation that the patient cannot run into their back teeth as they move in any excursive movement. It is important to note that if the condyle has the ability to move upward from the patient’s habitual occlusion, there will ALWAYS be an interference. Additionally if the lingual contours of the anterior teeth are not steeper than the patient’s posterior morphology, there will always be posterior teeth that bump and/or have the capacity to rub. This can be seen in working, balancing and/or protrusive movements. The primary reason back teeth should not contact in excursive movements, is because it dramatically increases the muscle activity, increasing the load to the dentition. Therefore, to decrease damaging excursive load to ceramic materials on the anterior teeth (as well as the natural dentition), always make sure there is immediate disclusion of the posterior teeth when the mandible moves in any direction.

3.) Anterior guidance in harmony with the envelope of function - If one of the goals is to prevent the back teeth from rubbing, it is logical to assume that it is the job of the front teeth to provide the disclusion. While some are questioning the importance of the anterior guidance, there is just too much scientific evidence already described in this article not to support its use. Simply stated, if the anterior guidance does not disclude the back teeth, then the capacity for back tooth contact in excursive movements and damaging muscle activity will be evident. It is simply risky to leave posterior interferences behind. However it is possible to make the anterior guidance too steep. Since the natural functional pattern of the patient during speaking and chewing is outside in, and not inside out, the contours need to be customized intraorally to make sure appropriate contours are tested to verify harmony with the envelope of function. An anterior guidance that is too steep will lead to fremitus, migration of the teeth, wear and/or fractured anterior teeth/restorations. It is important to recognize that posterior disclusion and contours that are in harmony with the EFO, don’t have to be mutually exclusive of one another. The optimum occlusion has to have both. Dr. Peter Dawson first described a technique that establishes this in 1974.

The optimum anterior guidance:

1.) Is steep enough to disclude the posterior teeth in any excursive movement.

2.) Is concave enough to be in harmony with the envelope of function.

It is critical for the restorative dentist to understand that when restoring anterior teeth, this precise concavity from the centric stop to the incisal edge position must be communicated to the dental laboratory. A digital protocol has now evolved to make this much more predictable then previous techniques.

Case Report

A 51 year old male was referred to the practice for occlusal evaluation and the fabrication of a sleep apnea appliance. He had been diagnosed with mild sleep apnea by a qualified physician and had been unable to wear a CPAP device (Figures 1-7). His mouth was healthy biologically, with no active dental caries and no probing depths greater than 3 mm. He did have mild localized gingivitis, and would need a couple of appointments with our dental hygienist.

Functionally, his primary sign of occlusal instability was occlusal wear. Teeth 6-11 and 22-27 exhibited through the enamel and into the underlying dentin. Tooth number 30 had a porcelain fused to metal crown with a fractured mesial lingual cusp. His first point was to tooth number 2,3,30,31 (Figure 8) in centric relation (CR) with a large slide to his maximum intercuspation. He also had balancing interferences bilaterally and there was also concern that his sleep apnea may be contributing to his occlusal wear. Ben complained of temporal headaches in the late afternoon and was aware of daytime clenching. Ben’s goals were to stabilize his bite, optimize his smile, and to be compliant with a sleep apnea appliance.

His treatment plan was created and placed into three phases.

Phase One: Treatment of Biologic Issues

The only biologic issue was the mild generalized gingivitis. The patient was scheduled with two visits with our hygienist.

- Appointment 1: Gross scale/Oral hygiene instructions
- Appointment 2: Prophy

Phase Two: Treatment of Functional Issues

Phase Two is about creating a functional stable base in which to build the definitive restorative dentistry. A combination of reductive equilibration to eliminate the interferences to centric relation, combined with additive equilibration utilizing composite resin to restore the incisal guidance, was the technique employed in this case (Figure 9,10). The goal was to create equal intensity contacts in centric relation, non-interfering posterior teeth (back teeth that can’t rub), and an anterior guidance in harmony with the envelope of function. In this phase an obtrusive sleep apnea orthotic was fabricated (TAP 3 device), and fitted for the patient (Figure 11). The patient desired to wait for a new insurance year (to maximize benefits) before proceeding to Phase Three. This worked out perfectly as it gave us time to test the new occlusion and to get the patient back to his sleep physician for a follow up sleep study. In the months that followed the occlusion remained comfortable, none of the resins fractured, and his headaches were eliminated. Additionally, we received a positive report from the sleep physician.

- Appointment 3: Equilibration, IFL resins 22-27,6-11, impressions OSA appliance
- Appointment 4: Deliver OSA appliance, fine tune equilibration
- Appointment 5: Adjust OSA appliance, complete equilibration refer back to sleep physician for confirmation of improvement
Phase Three: Restorative Dentistry (Placement of Permanent Crowns)

With the mouth stable biologically and functionally, the restorative phase of treatment should be uneventful. The teeth that will need to be restored are teeth 22-27, 6-11 and 30. Because the teeth are in an esthetic and functional optimum position, we can do these sextants in any order. The patient elected to begin with maxillary anterior teeth.

Phase Three began with new diagnostic impressions, facebow, centric jaw relations records and photographs. Their purpose was to do one final study of the occlusion and the esthetic contours. Slight alterations were made to the esthetic contours (diastema’s and line angles), while every effort was made to preserve the tested lingual contours. Teeth 6-11 were prepared with utilization of preparation reduction guides. A two cord technique was utilized and a final impression was taken, and a master model poured (Figure 12). Provisional restorations were created and cemented. Steps were taken to verify the functional goals previously described (Figure 13-15).

Digital Duplication

With all of the effort that has been taken to customize the patient’s anterior guidance, and ultimately create an optimum occlusal scheme, how we communicate these contours to the dental laboratory is extremely important. Previously, techniques have been described to cross mount the die model with a doctor and patient approved provisional model. The use of silicone putty to fabricate a labial matrix was utilized to precisely duplicate the incisal edge position. Whereas acrylic resin or light cured composite can be used to create a custom incisal guide table to facilitate the precise duplication of the lingual contours of the maxillary anterior teeth. While the author, along with many others, have utilized these modalities successfully for many years, there are times where predictability can be an issue. If the maxillary master casts and the provisional models are not mounted in the exact position in space, the incisal edge position and lingual contours will be wrong. This can and will create problems with some patients. Problems can include prolonged occlusal adjustments, all the way to the replacement of some or all of the restorations.

There’s little doubt that digital dentistry is changing many of the paradigms in our industry today. From taking the impression to fabricating restorations, digital technology is growing. Although many have adopted digital technology for their very basic dental needs, it is in some of the more complex case techniques where this technology may shine brightest. In comprehensive cases there has long been a gap between the ability to establish proper incisal edge position and contours in the anterior that will protect the posterior teeth and allow the system to function in harmony within the envelope of function and the replication by the laboratory of restorations.

Today, the savvy digital laboratory can exactly duplicate the key features of a perfected occlusion in restorative material by essentially “cloning” the approved provisional model. By utilizing a series of scans that can be “married” together, the orally established contours and edge position in a restorative material can be recreated.

This technique requires an impression (taken either conventionally or digitally) of the preparations, the opposing and bite relationship, and the approved provisional. This process first uses a scan of the die model (Figure 25). Next, the opposing model is scanned (Figure 26). Then, a scan of the approved provisional model is added (Figure 27). The computer will identify three or more exact points that allow the images to be synced together. This “cloning” is shown as an overlapping of the provisional restoration on top of the die model (Figures 28-29). On the design screen, the technician can view the preparations through a silhouette of the provisional. This allows the technician to evaluate space, such as the clearances for the restorative material. It also allows for some design tweaking within the matrix of the approved provisional that has been so carefully worked out in the mouth by the dentist (Figure 30) thereby keeping all the functionally critical occlusal features intact. Once the design has been completed, the technician can then choose to send the images to either the milling machine or to the rapid prototype printer to turn this occlusally perfect design into a restorative material. In this case, the design was sent to the printer creating resin (Figure 31). The resin prototypes can be placed on the models to evaluate fit and to confirm edge position in the incisal matrix (Figure 32). They will then be sprued like a wax-up, and invested and pressed into IPS e.max(Figure 33). These crowns were minimally cutback facially and layered with IPS e.max ceramic to achieve their final beauty (Figures 34-35).
Today the use of digital technology can make this duplication much easier. The restorative dentist goes through the exact same process of making a final impression and creating properly contoured provisional restorations as well as making an impression of the provisional restoration. The laboratory will then scan the master model as well as the approved provisional model. The lab will then “marry” the images so that they can see the exact three-dimensional contours over the digital master cast (Figure 16, 17). These restorations can then be virtually designed, ensuring from the centric stop to the incisal edge position that the critical contours are duplicated (Figure 18). It should be noted that if doctors are using one of the digital impression scanning systems the final impression and the approved provisional can be easily scanned. This will save a step in the dental laboratory. From this point the laboratory can either mill the copings or use a 3D printer. In this case the copings were printed (Figure 19). This facilitated the utilization of a micro cutback technique on the facial to enhance the esthetic result. The resin copings were then invested, and the crowns were pressed using the IPS e.max all ceramic system.

Figures 20-24 illustrate the final result. The restorations were bonded to place using Multilink selfetching cement, and then were finished and polished. It should be noted that this technique resulted in almost no occlusal adjustments. Minor finishing and polishing in a few areas was all that was required.

Conclusion
Optimum dentistry is about controlling all of the factors that can lead to the breakdown of the patient’s dentition. Biologic factors that manifest themselves as periodontal disease or dental caries are evident in many mouths. Occlusal disease that can manifest itself as wear, mobility, migration, or sore masticatory muscle soreness are also evident in many mouths.

This article has reviewed a protocol to get the mouth completely healthy, test the new occlusal contours, and utilize a digital technique to duplicate the tested occlusion much easier. It is incredibly exciting to see the evolution of these new technologies which help to make our hard work more predictable.

About the Author
John C. Cranham, DDS
Clinical Director of The Dawson Academy Private Practice, Chesapeake, VA

References
DIGITAL DUPLICATION OF THE ANTERIOR GUIDANCE
BY JOHN C. CRANHAM, D.D.S.

worn canines

Figure 3 - Preop retracted
Figure 4 - Preop-right lateral: note worn canine, DI edge of lateral
Figure 5 - Preop-left lateral: note worn canine, DI edge of lateral
Figure 6 - Preop-lower occlusal: Lower incisal wear into dentin, fractured ML cusp 30

Figure 7 - Preop-upper occlusal: Upper incisal wear into dentin

Figure 8 - Preop-first contact in CR on 2,3

Figure 9 - Postop phase II-additive and reductive equilibration complete

Figure 10 - Postop Phase II-restoration of incisal edges/incisal guidance

Figure 11 - TAP III Obstructive Sleep Apnea Appliance

Figure 12 - Phase III treatment, master cast maxillary arch 6-11

Figure 13 - Provisional left lateral smile

Figure 14 - Provisional lingual contour, steep enough to disclude the posterior teeth, concave enough to be in harmony with the envelope of function. Optimum occlusions have both of these qualities.
Figure 15 - Provisional restorations, retracted view

Figure 16 - Digital duplication of the provisional restorations. The marrying of the provisional model and the die model.

Figure 17 - Digital duplication of the provisional restorations. The marrying of the provisional model and the die model.

Figure 18 - The critical lingual contour duplicated from the centric stop to the incisal edge.

Figure 19 - The digitally printed copings

Figure 20 - Final EMAX restorations. Lingual contour to incisal edge is monolithic. The facial contours were micro layered.

Figure 21 - Occlusal view of final EMAX restorations

Figure 22 - Right lateral smile, final EMAX restorations

Figure 23 - Frontal retracted view, final EMAX restorations

Figure 24 - Right lateral retracted view, final EMAX restorations. 6-11. Patient can proceed with 22-27 and/or tooth 30 when he is ready.

Figure 25

Figure 26