CAD/CAM Occlusal splints: A new paradigm

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Occlusal splints are an essential part of everyday practice in both the treatment of TMD and protection of tooth-structure from parafunction. They can also be of benefit in "deprogramming" jaw musculature prior to extensive prosthodontic treatment or in helping to establish an appropriate vertical dimension of occlusion.

However, it can be difficult to achieve patient compliance and motivate patients to persistently wear occlusal splints, especially for passive, "night guard" type indications. Patients often complain that they feel uncomfortable, too tight or are too bulky to wear. They may also be self conscious with wearing a cumbersome and obvious occlusal splint with their bed partner.

Traditional methods of splint manufacture are highly technique sensitive and often lead to poor splint fit, overcontour and hence poor patient compliance. They also, more often than not, require extensive chair side time for adjustments to achieve passive fit and an appropriate occlusal scheme.

CAD/CAM technology has revolutionalised prosthetic and surgical dentistry. This technology has pervaded most areas of clinical dentistry and laboratory procedures from crown and bridgework through to implant surgical and restorative dentistry. The main benefits of CAD/CAM milling technologies are the elimination of individual human errors inherent in the casting and other technical processes, resulting in time savings and higher levels of predictability at both the technical and clinical level. It also allows the use of new or non-traditional materials that are not suitable for casting or other procedures.

Figure 1. DentaBite CAD/CAM milled splint upon initial insertion with centric and lateral excursive contact indicated, prior to any adjustment.

This article will review the functions and manufacture processes of traditional occlusal splints and look at a new CAD/CAM approach (DentaBite™, Stoneglass Industries) to occlusal splints, offering multiple advantages over traditional methodologies.

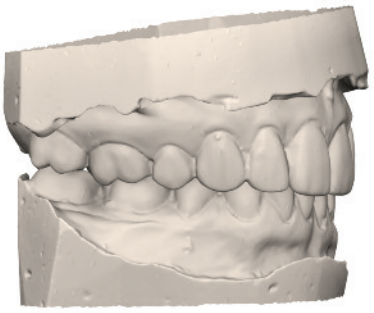

Figure 2a – Centric occlusion (CO) relationship.

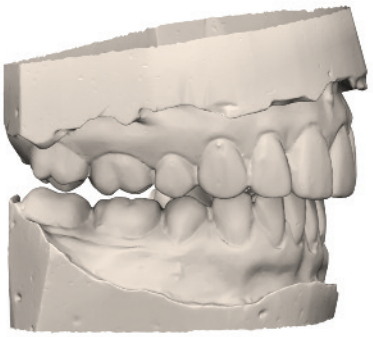

Figure 2b – Centric relation(CR) articulated occlusal relationship at desired vertical dimension.

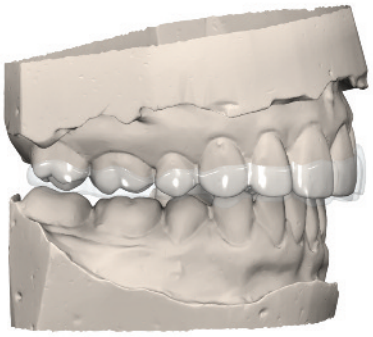

Figure 2c – completed DentaBite virtual design.

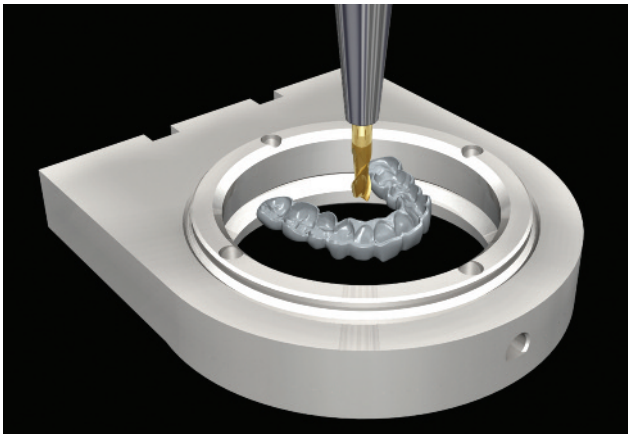

Figure 3. DentaBite in CAM milling position.

Figure 4. Stoneglass® precision milling jigs, DentaBite™ in situ.

Uses of an occlusal splint in dentistry

Occlusal splints have a multitude of uses in dentistry. However, they are also often subject to claims by some dental practitioners that they can cure TMD, attenuate parafunction, cure headaches, earaches, neck aches, backaches and even cure digestive disorders - in essence, occlusal splints have been oversold.

The main functions of occlusal splints are to treat the symptoms of TMD and protect the teeth from parafunction. A systematic review on the effectiveness of occlusal splints indicates variable results when compared to a placebo for the treatment of TMD.[1,2] There is some evidence that a change in occlusal vertical dimension (OVD) caused by splint use can affect the incidence of nocturnal parafunction, however this tapers off with time.[3] No evidence exists to support the concept that occlusal splints control any of the far reaching concepts that occlusal splints are sometimes claimed to do.

Given that the evidence demonstrates conflicting reports on the effectiveness of occlusal splints for specific disorders, we must ask what do they predictably do?

An occlusal splint then:

- Separates the upper and lower teeth;
- Protects the dentition from wear;
- Provides the patient with a smooth, balanced platform on which excursive movements can occur;
- Provides the patient with anterior guidance;
- Can assist to relax and de-program jaw musculature; and
- Eliminates unfavourable natural or prosthetic tooth contacts.

In essence, at a minimum, an occlusal splint prevents wear of tooth-structure by protecting the maxillary dentition and providing the lower dentition with a smooth, non interference plane which has a lower abrasive index than natural tooth structure and dentine.

Occlusal splint options

Many different designs of occlusal splints have been suggested and put forward over the years. They vary in design with:

- Fitting the maxillary or mandibular arch;
- Full occlusal coverage (Michigan design) or anterior only (NTI);
- Even bilateral contacts (Michigan design) or selective contact (Pivot and NTI splint);
- Anterior or posterior guidance;
- Provide occlusion in RP (Michigan design) or protrusion (Anterior repositioning splint); and
- Hard acrylic resin or plasticized liners or a combination of both.

It is not a fair comparison to state that all splints should be used for the same treatment, however there are multiple case reports in the literature that show medium to long term use of splints which do not provide simultaneous bilateral contact may induce irreversible occlusal changes.[4,5] There is also evidence in the literature that anterior repositioning splints can act as orthodontic devices and affect occlusions,[6,7] so their use must be justified against their potential efficacy and risks. For these reasons, the authors of this article prefer a stabilization splint, which does not induce occlusal changes, but in fact acts as a maxillary retainer.

Optimal design features of a stabilization splint

An ideally designed stabilization splint should[8]:

- Contact all teeth in at least one spot;
- Fit passively;
- Be a smooth flat plane;
- Provide the patient with anterior guidance for excursive movements;
- Be thick enough to withstand occlusal forces during parafunction;
- Be thin enough to be tolerable to the patient;
- Be slim enough to be consistent with strength;
- Be made from a material that is less abrasive than dentine but still be as strong as possible to minimize splint bulk and maximize splint longevity;
- Engage undercuts in a controlled manner so that the splint is retained intraorally for an entire evening of wear, but not be so engaging that it does not come in and out with ease; and
- Minimise chair time by being predictably accurate in both fit and occlusal scheme.

Occlusal splint fabrication methods

Occlusal splints can be manufactured by one of two methods – in a dental laboratory, or clinically. A traditional occlusal splint requires a wax up of the proposed occlusal scheme on surveyed and mounted casts, which is then invested and a clear heat-cured acrylic resin splint fabricated. The resin splint is then trimmed and polished and fitted back onto a duplicate of the investment cast. This traditional technique has several drawbacks, including polymerization shrinkage of the curing resin, the re-fitting of the splint to a stone cast (which abrades with the fitting procedures) and unpredictable occlusal contacts if not remounted and adjusted after processing.

Intraorally made splints are fabricated by creating a thermoplastic, vacuum formed "suck-down" of the patient's maxillary arch. This is then relined intraorally against the opposing arch with self-cure acrylic resin. This process can be quite uncomfortable for patients, as they have to suffer the unpleasant taste of acrylic resin in their mouth. Further, the chairside time is generally lengthy, as the splint then has to be carved out of the set resin block - a messy clinical/laboratory procedure. Also, occlusal splints require a minimal bulk in order not to fracture during function. For this reason, they may extend a fair distance onto the palatal tissue and be quite thick. This can result in patient discomfort and failure to wear the appliance.

Another variation of this theme is the well known "Somnobrux" type of appliance. This is a laboratory constructed and laminated type of occlusal splint which aims at achieving a more predictable and passive fit with improved patient comfort. There is a thermoplastic inner layer and hardened acrylic outer laminate. These splints are certainly an improvement on more traditional processed polymethylmethacrylate (PMMA) appliances, however, in the author's opinions, patient compliance and acceptance is compromised due to the added bulk and visibility of these appliances. Further, they require considerable chair side time in occlusal adjustment and refinement. Adjustments of these splints over time can also expose the softer underlying laminate which is also difficult to polish and can lead to weakened areas of the splint and vulnerable to cracks or fracture.

If made with attention to detail and care, traditional occlusal splints can be quite satisfactory. However, more often than not, dental laboratories may omit one or more steps in the re-fitting and occlusal adjustment after the splint is polymerized, increasing chairside time for the clinician and patient discomfort.

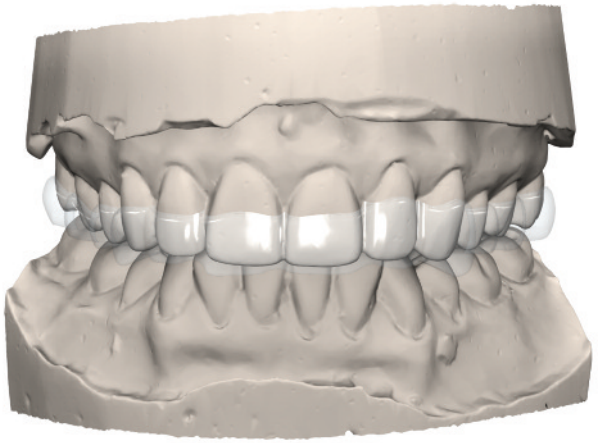

Figure 5. DentaBite finished splint, design and translucency, anterior view.

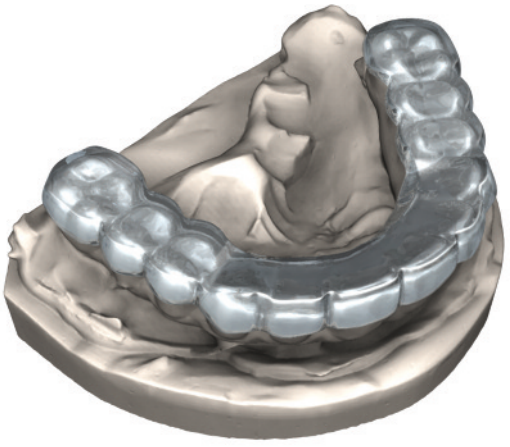

Figure 6. DentaBite finished splint, design and translucency, occlusal view.

A new CAD/CAM occlusal splint

DentaBite™ is a CAD/CAM occlusal splint that is designed using "DentaBite Splint Designer" technology and milled from a digital design, as opposed to cast from a wax prototype. They are made from life science grade polycarbonate, which has several advantages when compared with traditional acrylic resin materials, namely superior impact strength, yield strength and wear resistance (Table 1).

This allows the milled occlusal splint to be more durable, lighter, thinner and less bulky, hence improving patient comfort and compliance.

Clinically, maxillary and mandibular impressions are taken and poured to produce stone casts. A retruded-position MMR is also taken with no tooth contact and utilizing a vertical dimension stop. The authors utilize a custom vertical dimension jig to control the vertical relationship of the MMR. These models and MMR are digitized using a laser scanner and virtually articulated

Table 1. Comparative properties of PMMA and life science grade polycarbonate

	PMMA*	LSGPC
Charpy Impact Strength un-notched ISO 179-1/1eU	10 Kj/M sq	No break
Charpy Impact Strength notched ISO 179-1/1eA	2 Kj/M sq	9 Kj/M sq
Tensile Strength @ yieldISO 527	68 Mpa	74 Mpa
Elongation @ break ISO 527	4%	6%
Water absorption (24h immersion)	0.3%	0.15%

* Typical properties of Polymethylmethacrylate.

in centric relation and centric occlusion. The computer software also then calculates the centre of rotation of the condyle based on average values.

The maxillary model is digitally surveyed and the outline of the occlusal splint is constructed. Splint dimensions are automatically analysed to ensure a minimum occlusal thickness. This minimizes the risks of perforations of the splints (especially in the distal molar areas) or, alternatively, over-bulking of the splints which has significant dimensional issues anteriorly. Once the design of the splint has been digitally finessed, it is milled from a block of life science grade polycarbonate. The fit of the splint is then checked against the master model. The entire design process takes about 30 minutes and the milling process takes 90 minutes.

Experiences to date

The authors have been developing and trialling the DentaBite CAD/CAM occlusal splints at The Macquarie Street Centre for approximately 6 months with impressive results. We utilize these appliances for a variety of indications as discussed previously. The most frequent indication is for treatment of TMD symptoms and for protection of tooth structure from parafunctions such as bruxism. They also utilize these splints in most large reconstruction cases to de-program jaw musculature prior to occlusal records and to assist in the diagnosis and establishment of any changes in the vertical dimension of occlusion. Of course the use of protective night guards is mandatory for all full arch implant cases, where proprioception protection is hence compromised.

The authors have found minimal chairside time needed in fitting the appliances and reduced time in adjusting the occlusion. The turnaround time for an occlusal splint is 3 to 5 working days and the costs are comparable with current manufacture techniques. Most importantly, patients, especially those who have previously used processed acrylic or laminated splints, favourably comment on the comfortable fit and decreased bulk. The authors believe they have certainly had improved uptake and compliance with the wear of occlusal splints and night guard type of appliances and their clinical efficacy has been significantly improved.

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About the authors

Dr David Dunn graduated from the University of Sydney with Honours in 1981. He is a Fellow by examination of the Royal Australian College of Dental Surgeons and is a member of the prestigious Pierre Fauchard Academy. He was instrumental in the establishment of both the Osseointegration Society of New South Wales, being chairman of the inaugural committee, and later The Australasian Osseointegration Society. He is a Senior Clinical Associate at the University of Sydney, Faculty of Dentistry. He has also been a Faculty member for the teaching of the "The Diploma in Implant Dentistry," University of Sydney. Dr Dunn has lectured both nationally and internationally including The Royal Australasian College of Dental Surgeons 2000 Congress, The Australian Dental Congress, the Asia Pacific Dental Congress, New Zealand Dental Association Congress, Nobel Biocare World Conferences and numerous local programs. He also conducts mentor training programs to educate and improve the skills of dentists who are involved in dental implant therapy and is a member of the international teaching faculty for gIDE/ULCA Master Program in Implant Dentistry. Dr Dunn's recently renovated practice, The Macquarie Street Centre, in Sydney, is restricted to Prosthodontics with a special interest in cosmetic and implant reconstruction.

Dr Michael Lewis graduated with a Doctor of Clinical Dentistry at the University of Sydney in 2010. During his specialisation program at Westmead hospital he received extensive training in aesthetic and implant dentistry, restorative dentistry and conventional crown and bridge, denture prosthetics and orofacial pain management. He is the proud recipient of the John H Wilson prize for proficiency in prosthodontics and the Campbell Harry Graham prize in Prosthetic Dentistry. Dr Lewis is pleased to announce that he has commenced specialist Prosthodontic practice at The Macquarie Street Centre. We welcome referrals and look forward to aiding you in your patient treatment.