The Basics of Occlusal Splint Therapy

Treatment of occlusal-related disorders is often a challenge for both the dentist and the patient. These disorders are often difficult to diagnose, as the presenting symptoms can be variable. Occlusal splint design and function can be considered an example of the art and science of dentistry. Once the cause of occlusal-related disorders is identified, this reversible, noninvasive therapy provides both diagnostic information and relief without the problems that often accompany other approaches to care, i.e., surgery and extended drug therapy.

The goal of this article is to familiarize "physicians of the masticatory system" with the basic principles of occlusal splint therapy for treating temporomandibular disorder (TMD), bruxism, and some forms of headache.

WHAT IS OCCLUSAL SPLINT THERAPY?
Occlusal splint therapy may be defined as "the art and science of establishing neuromuscular harmony in the masticatory system by creating a mechanical disadvantage for parafunctional forces with removable appliances." A properly constructed splint facilitates a mutually protected occlusion (Figure 1).

WHAT TYPES OF SPLINTS ARE AVAILABLE?
The types of splints currently employed in occlusal splint therapy include permissive, nonpermissive, hydrostatic, and soft rubber (silicone) splints. The permissive splints allow the teeth to glide unimpeded over the biting or contact surface. These include bite planes (anterior deprogrammer, Lucia jigs, anterior jigs) and stabilization splints (Tanner, centric relation, flat plane, and superior repositioning).

The nonpermissive splints have ramps or indentations that limit the movement of the mandible. Examples include an anterior repositioning appliance (ARA) and a mandibular orthotic repositioning appliance (MORA) (Figure 2).

Soft rubber splints and hydrostatic splints (Aqualizer, Jumar Corp) function by separating the teeth. Soft rubber splints, however, do not provide the characteristics necessary for successful splint therapy. These splints can exacerbate bruxism, possibly due to premature posterior contacts related to the fact that these splints cannot be balanced.

HOW DO SPLINTS WORK?
Splints provide diagnostic information, allow muscles in spasm to relax, protect the teeth
and jaws from the adverse effects of bruxism, and normalize periodontal ligament proprioception. These devices can also allow repositioning of the condyles and jaws into centric relation (CR).2

Providing Diagnostic Information
Occlusal splints provide diagnostic information in different ways. The restorative dentist can determine the envelope of function, potential neutral zone impingements, parafunctional habits, and anterior guidance requirements, as well as obtain information about vertical dimension from patients who wear a splint. A study of patients with nocturnal bruxism revealed that 13% exhibited isometric clenching, 71% exhibited bilateral clenching, 18% exhibited unilateral clenching, and 0% exhibited protrusive movement (Figure 3). The treating clinician can predict from this information that a large percentage of patients requiring restorative treatment may exhibit lateral parafunctional forces that could damage the natural and prosthetic dentition. Cusp shapes, sizes, angulations, and depths can be evaluated and properly designed if this information is available prior to treatment.

Temporomandibular (TM) joint that does not achieve total muscle relaxation with treatment. This can indicate a more advanced joint disorder than originally diagnosed. This author considers splint wear mandatory prior to extensive restorative therapy.

Muscle Relaxation
The literature has shown that tooth interferences to the CR arc of closure activate the lateral pterygoid muscles; posterior tooth interferences during excursive mandibular movements cause hyperactivity of the closing muscles; and conversely, that the elimination of posterior excursive contacts by anterior guidance significantly reduces elevator muscle hyperactivity. Even small (50 μm) occlusal interferences can initiate changes in coordinated muscle activity.10

Headache is observed in many TMD patients.11,12 The effectiveness of splint therapy in reducing head and neck pain and muscle hyperactivity is well documented.13,14 A specific anterior deprogrammer known as the nociceptive trigeminal inhibition (NTI) appliance has recently been approved by the FDA for the prevention of medically diagnosed migraine headache pain.15 Occlusal splints promote muscle relaxation by providing a platform for the teeth that allows for equal distribution of tooth contacts, immediate posterior tooth disclusion in all movements (with anterior guidance), and reduced stress on the joint. Neuromuscular harmony that follows provides for optimal function and comfort.

Protecting Teeth and Jaws From Bruxism
Bruxism has been defined as "the grinding or clenching of teeth at other times than for the mastication of food."16 Certain authors have suggested it is only a nocturnal activity.19 A CR-balanced splint can provide protection from the potentially adverse effects of this parafunctional activity.

Studies examining the occurrence of bruxism have reported prevalence ranging from 6.5% to 88%.20 The forces generated during bruxism can be as much as six times the maximal force generated by normal chewing.21 Since the average force generated by normal chewing is 182 pounds per square inch,22 patients who brux should be identified and treated as required. Identification involves examination of the teeth, support tissues, muscles of mastication, and TM joints. Signs or symptoms of bruxism should be countered with a nocturnal CR-balanced splint prior to and after any restorative intervention.

It is important to remember that splints do not prevent bruxism, rather, they distribute the force across the masticatory system. These appliances can decrease the frequency but not the intensity of the bruxing episodes.23

An interesting study by Nitzan suggested another pathologic mechanism.24 Cellular hypoxia can take place when capillary perfusion pressure is above 285 mm Hg. Needles were inserted into the superior joint space of dental students during maximal clenching, both with and without a flat plane appliance in place. Pressures exceeding 200 mm Hg were observed when clenching without the splint, but pressures were less than 25 mm Hg when clenching with the splint. With compression of the vessels, the affected area has reduced blood flow, which will adversely affect normal function and wound healing.

Normalizing Periodontal Ligament Proprioception
The attachment of a tooth to the osseous (alveolar) housing is via the periodontal ligament. Contained within this collagenous structure are sensors (proprioceptive fibers) that perceive force. Messages received from the ligament are transmitted through nerve fibers to the central nervous system, triggering muscle patterns that protect the teeth from overload. Using an animal model, Hanum and coworkers25 demonstrated that stimulation of pressure receptors in the periodontal ligament led to a jaw-opening reflex. Hellings demonstrated that muscle changes occur with tooth contact and that periodontal afferent feedback (sensory nerve feedback) must be responsible for this rapid adaptation.22 An occlusal splint functions to dissipate the forces placed on individual teeth by utilizing a larger surface area covering all teeth in the arch. Once fabricated, a splint must be continually adjusted to re-establish equal contact, balance.

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ance the load, and allow for muscle symmetry.

Allowing Condylar Seating in CR
CR is defined as "the relationship of the mandible to the maxilla when the properly aligned condyle/disc assemblies are in the most superior position against the eminＲentia irrespective of tooth position or vertical dimension." CR can be a starting point for determining the relationships of the teeth, discs, bones, ligaments, and muscles (Figure 4). The condyle/disc assembly is allowed to seat in CR (Figure 5) when the superior or bottom of the lateral pterygoid muscle obtains its full extension due to minimal positioning muscle hyperactivity, which dictates tonic muscle activity as opposed to any type of muscle hyperactivity. The TM joints are load bearing, specifically during parafunctional activities and forceful mastication or biting. During loading, the elevator muscles (mainly the temporalis and masseter) can exert maximal force with a totally relaxed lateral pterygoid and a disc that is physiologically located. When the lateral pterygoid is triggered by hyperactivity through occlusal stimuli, the disc is pulled anteromedially toward the origin of the muscle, resulting in displacement. In this case the disc, condylar head, ligaments, and muscle are under excessive loading and are susceptible to damage. Chronic and acute overloading of the condyle/disc assembly when not in normal physiologic position contributes greatly to the development of TMD. A properly balanced splint results in an occlusion associated with relaxed positioning of elevator muscles, allowing the articular disc to obtain its antero-superior position over the condylar head. Splint therapy can utilize CR as the physiologic treatment position. This is contraindicated in situations where inflammation of the joint results in pain. The condyles may have to be in an anterior-inferior joint position until the inflammation subsides and CR is achievable. The literature supports repositioning into CR. Curtis and coworkers demonstrated that splints designed to provide a lateral deviation of the centric arc of closure resulted in bone density changes in the condyles of monkeys. The monkeys positioned in CR did not experience changes in the condyles. Pressure may be associated with cartilage breakdown and arthritis in the condylar heads.

WHICH TYPE OF SPLINT SHOULD BE USED AND WHEN?
The type of splint utilized is dependent on the diagnosis. A carefully planned dental history along with a comprehensive examination is necessary for all patients, but especially those with facial pain, TMD, or bruxism. If the patient reports bruxism and headaches but no TMD, the use at night of a full-coverage splint, in which acrylic covers an entire arch of teeth, is often adequate to protect the teeth. Muscle relaxation is an added benefit that often relieves or eliminates tension headaches. The choice of the arch for which the splint is fabricated is dictated by the type of bruxism habit. If the patient clenches isometrically, a full-coverage maxillary guard with all of the teeth in contact is appropriate. With isometric clenching, the maxillary anterior teeth would not be compromised on a mandibular splint, and since no movement takes place, this force would not be properly distributed using this type of splint. If the patient demonstrates parafunctional movement laterally, a mandibular splint that does not touch all of the anterior teeth is acceptable (it must touch the cuspsids for guidance, but to extend it to touch the incisor teeth would be uncomfortable and unsightly). Pressure is not transferred to only the posterior teeth because movement is so dynamic. If there is a question regarding the extent of mandibular night-time movement, a maxillary splint is preferred. The occlusal thickness of the splint has been addressed in the literature. Manns et al showed that splints that increased vertical dimension 4.4 mm and 8.2 mm were more effective in producing muscular relaxation in patients with bruxism and myofascial pain dysfunction than 1-mm splints. Piper suggested a 12- to 15-mm distance (incisal edge to incisal edge) to decrease clenching efficiency. These studies suggest that a minimum of a 4-mm increase in vertical dimension is necessary to protect bruxing patients. If the patient is wearing a splint 4 mm in thickness and still experiences muscular soreness, headache, and/or facial muscle tight-
more damage. Stabilization splints are the treatment of choice, as they provide long-term wear that is usually needed. They also cover the entire dental arch, ensuring that the covered teeth do not move. They must be worn continually for 24 hours (except when eating) for as long as required to eliminate muscle, disc, liga-
ment, and tooth symptoms. Three to 6 months of wear is often required. These disorders may be reversible if detected relatively early and treated appropriately.

Advanced disc and muscle disorders are identified in patients who experience jaw locking and/or noises, 

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painful joints, and sometimes increasing pain with splint wear. Patients with acute trauma may require an anterior repositioning appliance for 7 to 10 days to keep the condyle away from the retrodiscal tissues, so inflammation can subside. These patients often have a long history of joint pain, locking, and instability. Stabilization splints are the treatment of choice, and must be balanced to accommodate the specific needs of the patient (ie, many patients require shallow cuspid guidance in lateral or protrusive movements to eliminate joint clicking). Splints may need to be worn for 6 months to 2 years depending on the patient.

If interferences on the splint are continually eliminated by rebalancing into CR, the patient will realize long-lasting relief from symptoms.

These disorders are usually not reversible, but with treatment patients can experience amelioration of symptoms.

HOW OFTEN SHOULD SPLINTS BE ADJUSTED?
In a study by Holmgren et al, occlusally induced changes (indentations) were observed every 2 weeks in 61% of patients. The remaining 39% also demonstrated changes at different times, namely indentations in the acrylic, indicating some grinding movements or static indentations. This suggests that more than half of splint patients require post-delivery visits before 2 weeks. A suggested protocol would include adjustments at 24 hrs, 3 days, 7 days, 14 days, 21 days, and 1 month. When no movement on the splint is seen at adjustment appointments and symptoms are improving, the intervals between adjustments can be extended, and the patient told to call for an appointment if symptoms worsen. The splint must be continually monitored and adjusted to ensure equal contacts on all teeth, with immediate discusion of the posterior teeth in all movements. When muscle relaxation is achieved and/or inflammation subsides, the position of the teeth on the splint will change. Neuromuscular harmony often returns when readjustment to the CR position is accomplished. If interferences on the splint are continually eliminated by rebalancing into CR, the patient will realize long-lasting relief from symptoms.
Proper diagnosis and fabrication of the appropriate device can often result in relief of symptoms.

CONCLUSION

Familiarity with the application of splint therapy for patients with occlusal-related disorders can be one approach to treatment of affected individuals. Proper diagnosis and fabrication of the appropriate device can often result in relief of symptoms.*

References


1. "Permissive" splints:
   a. lock the teeth into the splint.
   b. are made of soft rubber.
   c. can be hydrostatic.
   d. allow the teeth to glide freely.

2. Split functions do not include:
   a. relaxing muscle.
   b. unloading the joint.
   c. protecting the teeth from bruxism.
   d. reducing cellular hypoxia.

3. Uncoordinated muscle activity could be initiated by a tooth interference as small as:
   a. 50 μm.
   b. 70 μm.
   c. 90 μm.
   d. 110 μm.

4. Occlusal splints provide a platform for the teeth that:
   a. is always arched.
   b. is always flat.
   c. allows for equal intensity tooth contact.
   d. allows for immediate anterior disclosure by the posterior teeth.

5. What is not true about TMD?
   a. Acute loading of the condyle/disc assembly when it is out of its physiologic position contributes to TMD.
   b. TMD is a nonspecific term.
   c. TMD is never initiated by occlusal abnormalities.
   d. Some TMD problems are reversible.

6. In reference to patterns of nocturnal bruxism:
   a. animal models have been used, making extrapolation to the clinic difficult.
   b. < 20% of patients clenched isometrically.
   c. 3% of patients were unilateral excursion marks in the splints.
   d. no general trends are observed.

7. Patients who brux:
   a. are uncommon in the adult population.
   b. generate minimal forces compared to non-bruxers.
   c. are difficult to identify.
   d. should be identified and treated.

8. When considering occlusal splint therapy, it is important to note that:
   a. headaches can be alleviated with splint therapy.
   b. splint thickness is not an important consideration.
   c. splints should always be placed on the maxillary arch.
   d. bite plane therapy should not be used for muscle disorders.

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