The Essentials of Occlusal Splint Therapy
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Abstract
Occlusal splint therapy has been used for many years for the diagnosis and treatment of various disorders of the masticatory system. This article will familiarize the reader with basic splint designs and explain how to use these effectively.

Key words- bite splint, occlusal splint, occlusal device, occlusal appliance, temporomandibular dysfunction, temporomandibular joint disorder, bruxism.

Introduction
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"(1). Occlusal splint is a diagnostic, relaxing, repositioning and reversible device. According to the Glossary of Prosthodontic Terms [8th ed.], "occlusal splint is defined as any removable artificial occlusal surface used for diagnosis or therapy affecting the relationship of the mandible to the maxilla. It may be used for occlusal stabilization, for treatment of temporomandibular disorders, or to prevent wear of the dentition." A bite splint can be a valuable diagnostic and treatment aid in carefully selected cases if properly made, adjusted and maintained. A properly constructed splint supports a harmonious relation among the muscles of mastication, disc assemblies, joints, ligaments, bones, teeth and tendons. It provides a relatively easy, inexpensive and non-harmful way to make reversible changes in the occlusion.

Main reasons for occlusal splint therapy
Occlusal splint therapy has been shown to be useful for the diagnosis and management of various masticatory system disorders(2). A common reason for prescribing an occlusal splint is to protect the teeth from excessive wear in patients with bruxism. Splints are also used frequently to treat patients with internal derangement and other TMDs with associated symptoms, such as tension headache and cervical, neck and oral/facial pain(3-6).

How do splints work?
There is no general agreement about if or why splint treatment may have a beneficial effect. Following are few concepts, which explain how occlusal splints can help. Preventing the patient to close in maximal intercuspal position: By occlusal splint, the patient is obliged to place his mandible in a
new posture, thus resulting in a new muscular and articular balance. The patient, disturbed in his habits will not clench his teeth any more, like before and protect his TMJ and teeth(7).

Distribution of forces: The forces generated during bruxism can be as much as six times the maximal force generated by normal chewing(8). The splints distribute these forces across the masticatory system. These appliances can decrease the frequency of bruxing episodes but not the intensity(9).

Normalising periodontal ligament proprioception: Proprioceptive fibres contained in the periodontal ligament of each tooth send message to central nervous system, triggering muscle patterns that protect them from overload. An occlusal splint functions to dissipate the forces placed on individual teeth by utilizing a larger surface area covering all teeth in the arch. Thus a splint balances the load and allows for muscle symmetry.

Relaxing the muscles: Tooth interferences to the CR arc of closure hyperactivate the lateral pterygoid muscles and posterior tooth interferences during excursive mandibular movements cause hyperactivity of the closing muscles. A muscle that is fatigued through ongoing muscle hyperactivity can present with pain. If the hyperactivity is stopped, the pain caused by it will usually disappear. A splint with equal intensity contacts on all of the teeth, with immediate disclusion of all posterior teeth by the anterior guidance and condylar guidance in all movements, will relax the elevator and positioning muscles(10).

Allowing the condyles to seat in centric relation: For the condyles to seat completely under the disc in anterosuperior position, the superior belly of lateral pterygoid should obtain its full extension. When the lateral pterygoid is triggered to hyperactivity through occlusal stimuli, the disc is pulled anteromedially toward the origin of muscle, resulting in displacement. Overloading of condyle/disc assembly when not in normal physiologic position contributes towards TMJ disorders. A properly balanced splint results in an occlusion associated with relaxed positioning and elevator muscles, allowing the articulator disc to obtain its antero-superior position over the condylar head.

Increase in the vertical dimension of occlusion: Occlusal splints can be adjusted with a vertical height that exceeds the physiologic interocclusal distance. Temporary use of occlusal splints with a vertical height exceeding the physiologic rest position does not cause increase in tonus or hyperactivity of jaw muscles. Studies have shown that elongation of elevator muscles to or near the vertical dimension of least electromyographic activity by means of occlusal splint is effective in producing neuromuscular relaxation(11,12).

Cognitive awareness theory: According to this theory, the presence of the splint as a foreign object in the mouth would likely change the oral tactile stimuli, decrease the oral volume and space for the tongue and make the patient conscious about the position and potentially harmful use of their jaw. As cognitive awareness is increased, factors that contribute to the disorder are decreased. The result is a decrease in the symptoms.

Placebo effect: A positive placebo effect may result from the competent and reassuring manner in which the doctor approaches the patient and provides the therapy. This favorable doctor-patient relationship, accompanied by an explanation of the problem and reassurance that the appliance will be effective, often leads to a decrease in emotional stress experienced by the patient, which may be the significant factor responsible for the placebo effect.

Increased peripheral input to the central nervous system: Nocturnal muscle hyperactivity appears to have its source in
the CNS. When an occlusal splint is placed between the teeth, it provides a change in peripheral input and thus decreases CNS-induced bruxism. All these concepts overlap and are not mutually exclusive.

**Types of Occlusal Splints**

**According to Okeson** (13)
- Stabilization appliance
- Anterior repositioning appliances

Other types:
- Anterior bite plane
- Posterior bite plane
- Pivoting appliance
- Soft/resilient appliance

**According to Dawson** (14):
- Permissive splints/muscle deprogrammer
- Directive splints/non-permissive splints

**Permissive Splints:** Are designed to unlock the occlusion to remove deviating tooth inclines from contact. This eliminates the cause and effect of muscle in co-ordination. The condyles are then allowed to return to their correct seated position in centric relation if the condition of the articular components permits.

Permissive splints are often referred to as muscle deprogrammers. The two classic designs of permissive splints are anterior midpoint contact splints and full contact splints. Examples of anterior midpoint contact splints include nociceptive trigeminal inhibition (NTI) splint, Lucia jig and the B splint, and the example of full contact splint is centric relation splint.

**Directive splints:** Are designed to position the mandible in a specific relationship to the maxilla. The sole purpose of a directive splint is to position or align the condyle-disc assemblies. The jaw to jaw relationship that results from maximum intercuspation with the splint determining where the condyles must be at the intercuspal position. Thus directive splints should be used only when a specifically directed position of the condyles is required. Anterior repositioning splint is a directive splint.

**Specific Uses of Different Types of Splints**

**STABILIZATION SPLINT:**
Stabilization splint is also known as the superior repositioning splint, the Tanner appliance, the Michigan splint, the Fox appliance or the centric relation appliance. The stabilization splint is a hard acrylic splint that provides a temporary and removable ideal occlusion. Providing an ideal occlusion by the use of splint therapy reduces abnormal muscle activity and produces neuromuscular balance (15). It is suggested that patients should wear the splint only at night. The splint needs to be adjusted (rebalancing of the splint to the new position of the jaw by grinding some of its surface points, since the lower jaw will adopt a new position as a result of wearing the splint) over several visits as the masticatory muscles relax until a consistent jaw relationship is reached. The patient should be reviewed at regular intervals. After a period of successful splint therapy (between 2 to 3 months), patients can be weaned off the splint.

A stabilization splint provides centric relation occlusion, eliminates posterior interference, provides anterior guidance and gives stable occlusal relationships with uniform tooth contacts throughout the dental arch.

![Figure 1. Upper stabilizing splint](image-url)
Indications:

- The stabilization splint is most efficacious for masticatory myalgia and TMJ arthralgia, especially if the pain is worse upon awakening. This type of splint can also be used during the day for oral habit management. Such splints are designed to provide postural stabilization and to protect the TMJ, muscles, and teeth.

- The centric relation splint is generally used to treat muscle hyperactivity (16). Studies (17, 18) have shown that wearing it decreases parafunctional muscle activity. Patients with myospasms or myositis are best treated with centric relation splint.

- The symptoms of patients who experience trauma or suffer an inflammatory joint disorder and have a co-existent factor of parafunctional activity are managed successfully with centric relation splint therapy.

- It is also used in reducing symptoms from parafunctional activity associated with increased levels of emotional stress.

Careful adjustment of the stabilization splint is an important step as muscle activity changes and edema subsides. Acute pain can be caused by inflammation in intracapsular TMJ tissues. They may swell or shrink during different stages of the disease period. Repeated adjustments may have to be made for quite long periods.

ANTERIOR REPOSITIONING SPLINT

The anterior repositioning splint induces a therapeutic mandibular position, forward to the maximum intercuspation position of the patient and affects the physiological-topographical relationship of the disc-condyle complex (19, 20). The anterior repositioning splint places a patient’s mandible and TMJ into an anterior position so as to reduce a TMJ click that occurs on opening and closing of the jaw. The anterior repositioning splint is typically placed on the maxillary arch with an anterior ramp that first engages mandibular teeth on initial closure and shifts the jaw forward into final closure, when all mandibular teeth contact the splint. This position provides a more favorable condyle-disc relationship in the fossa so that normal function can be established. The goal is to eliminate the signs and symptoms associated with disc-interference disorders. The treatment goal is not to alter permanently a mandibular position but ideally to alter only temporarily while normal condyle-disc complex function returns. Once the function is again optimal, treatment consists of gradually eliminating the splint and returning the patient to preexistent normal condition.

Figure 2 anterior repositioning splint

Indications

Anterior repositioning splints can be efficacious for intermittent jaw locking with limited range of motion, especially upon awakening, or for persistent TMJ arthralgia not responsive to other therapy (including a stabilization splint). They are recommended only for short-term use because they can cause occlusal changes if worn continuously or chronically.

- Anterior repositioning splints are used primarily to treat disc-interference disorders.
• Patients with joint sounds such as single or reciprocal clicks can sometimes be effectively treated with this type of splint.
• Intermittent or chronic locking of the joint
• Inflammatory disorders (e.g. retrodiscitis)

ANTERIOR BITE PLANE
The anterior bite plane is a hard acrylic appliance worn over the maxillary teeth that provides contact with only the mandibular anterior teeth. It is primarily intended to disengage the posterior teeth and thus eliminate their influence in the function or dysfunction of the masticatory system. Anterior jig, Lucia jig, Hawley with bite plane, anterior deprogrammer and Sved plate (21) are types of anterior bite plane.

Indications
• Treatment of muscle disorders related to orthopedic instability or an acute change in the occlusal condition.
• Parafunctional activity associated with unfavorable posterior tooth contacts can also be treated but only for short periods.

If the appliance is worn continuously for several weeks or months, it is likely that the unopposed mandibular teeth will supraerupt. When this occurs and the appliance is removed, it results in an anterior open bite. Anterior bite plane therapy must be closely monitored and used only for short periods.

POSTERIOR BITE PLANE
The posterior bite plane is usually fabricated for the mandibular teeth and consists of areas of hard acrylic located over the posterior teeth and connected by a cast metal lingual bar. The treatment goals of the posterior bite plane are to achieve major alterations in vertical dimension and mandibular repositioning. The Gelb (Gelb-MORA [mandibular orthopedic repositioning appliance]) splint(22) is a type of posterior bite plane.

Figure 3. Gelb-MORA Splint.

Indications
• Severe loss of vertical dimension
• When major changes in anterior positioning of the mandible are needed.

The major concern with this appliance is potential supraeruption of the unopposed teeth and the intrusion of the occluded teeth. Constant and long term use is discouraged.

PIVOTING SPLINT
The pivot splint is also known as distraction splint. The pivot splint was introduced by Krough-Poulsen. It is a hard acrylic appliance that covers one arch and usually provides a single posterior contact in each quadrant. This contact is usually established as far posteriorly as possible. The proposed effect is that the condyles are pulled downward upon clenching on the pivot, thereby relieving traumatic load and giving the disc freedom to reassume a normal position.

The pivoting splint was originally developed with an idea that it would create a decrease in interarticular pressure, thus unloading the articular surface of the joint. This was thought to occur when the anterior teeth moved closer together, creating a fulcrum around the second molar and pivoting the
condyle downward away from the fossa. However, this can occur only if the forces that close the mandible are located anterior to the pivot. Unfortunately, the forces of the elevator muscles are located primarily posterior to the pivot, which therefore does not allow any pivoting action. It was originally suggested that the therapy was helpful in treating joint sounds. It now appears, however, that the anterior repositioning splint is more suitable for this purpose since it provides more controlled repositional changes. In fact, the pivoting appliance has been advocated for the treatment of symptoms related to degenerative joint diseases of the temporomandibular joint. It has even been suggested that the splint be inserted and elastic bandages be wrapped from the chin to the top of the head to decrease forces in the joint.

**Indications**

- To unload the articular surface of the joint caused by decrease in inter-articular pressure.
- Treating joint sounds.
- For the treatment of symptoms related to degenerative joint diseases.

**SOFT OR RESILIENT SPLINT**

The soft splint is an appliance fabricated from resilient material and usually adapted to the maxillary teeth. Treatment goals are to achieve even and simultaneous contact with the opposing teeth. It is quick to fabricate and can be provided as ‘emergency treatment’ for a patient who presents with an acute TMD. The only record needed is an upper alginate impression. These appliances are generally worn only at night and if they are successful, will produce symptomatic relief within 6 weeks. They should be replaced after 4 – 6 months as they lose their resilience with the passage of time.

The appliance is generally made out of 2 - 4 mm polyvinyl sheet. If a thinner splint is required, laboratory can be instructed to overheat the material before vacuum forming and if a thicker appliance is required (for patient with an anterior open bite), then layers can be added in certain areas (i.e. anteriorly) to ensure even occlusal contact.

![Figure 4. Athletic mouth guard](image)

**Indications:**

- In reducing symptoms of temporomandibular disorders (joint dysfunction and myalgia).
- Protective device for persons likely to receive trauma to their dental arches (athletic splint)
- To prevent bruxism and clenching
- For relief of extremely sensitive posterior teeth due to chronic or repeated sinusitis.

The soft splints are less likely to cause significant occlusal changes that are sometimes noted with hard occlusal splint. They have low density and amorphous structure, therefore they are compressed or worn before the masticatory muscles are stretched or stressed beyond their physiologic limits.

**BITE SPLINT ACCORDING TO SHORE**

This splint has a design similar to the stabilization splint but does not extend onto
the facial or buccal surfaces of the teeth, and covers the entire palatal area. It may be preferred by some patients who need to use the splint during daytime, for esthetic reasons, because it can be made less visible. In some patients with parafunctional tongue activities, such a palatal extension may be felt more comfortable. A centric relation splint can easily be changed into this type by removing facial and buccal extensions, adding palatal cover and, if needed, securing adequate retention with clasps.

**CAP SPLINT**
A cap splint can be described as an intermediary between a splint and a bridge. It is useful for temporary reconstruction before final decision about design, vertical dimension, etc., can be made. It is often made with metal with the occlusal surface in hard acrylic.

**HYDROSTATIC APPLIANCE**
(Commercial name: Aqualizer)
It employs water to balance the biting pressure, to treat malocclusion and to relieve TMJ pain and symptoms associated with TMDs(23,24). When the hydrostatic cell is inserted between the arches, a sequence of reorganization spreads throughout the stomatognathic system, all occlusal disharmonies are compensated automatically by distribution of fluid within the cell. Occlusal forces to every tooth contacting the cell there by becomes systematically equalized and axially oriented.

The volume of fluid within the cells is adjusted to obtain the desired degree of increase in the vertical dimension of occlusion. Occlusal forces that normally arise individually as the result of many maxillary and mandibular tooth contacts now are created as a whole within the hydrostatic cell and distributed to each tooth that contacts the cell. The occlusal forces transmitted to each tooth are hypothesized thereby to become optimal, these forces now arise simultaneously and are perfectly equalized (in accordance with Pascal’s law which states that an enclosed fluid distributes forces equally and simultaneously in all directions) and horizontally displacing contacts are reoriented axially.

The hydrostatic appliance is worn 24 hours and removed only while eating, for a period ranging from several weeks to years. The cells retain their fluid an average of about two weeks. A new cell is installed when the enclosed fluid escapes.

**NTI (Nociceptive Trigeminal Inhibition) Tension Suppression System**
(By Dr. James Boyd)
The direct stimulation of the periodontal ligament of the lower incisors activates a feedback loop, which significantly limits the contraction intensity of the closing muscles. This is because of the nociceptive trigeminal inhibition (NTI) reflex.

The NTI appliance takes advantage of this reflex via an acrylic guard worn on either the mandibular or maxillary incisors. Stock NTIs are relined with self-cure acrylic.

![Figure 5. NTI splint](image.png)

**SPLINTS FOR PROTECTION OF ORAL TISSUES**
The most common reason for making a splint is to protect the teeth from excessive abrasion in bruxers, Several variations of
splints are designed to protect cheeks and tongue in patients with oral parafunctions (such as cheek biting or tongue thrust). These patients may benefit from a splint with extensions or enlargements designed in a way that keeps the cheeks from being pinched or the tongue from pressing against the lingual surfaces of the teeth.

**COMBINATION SPLINTS**

Missing teeth can easily be replaced by adding artificial teeth to the splint. A Shore splint can function as a temporary partial denture by adding artificial teeth. There are numerous combinations of splint and orthodontic appliances. A removable bionator appliance can act both as an orthodontic and as a repositioning appliance (25). An “invisible retainer” can simultaneously act as a soft acrylic splint.

![Bionator](image)

**LOCATION OF SPLINT: MAXILLARY OR MANDIBULAR**

Presumably it is possible to obtain the same results regardless of the situation of the occlusal splint but the choice of the individual situation depends on a few basic principles. If teeth are missing, the splint is usually made in the jaw where most teeth are lost to increase the stabilizing effect by creation of additional occlusal points. If molars and premolars are missing in both jaws, it may be advisable to make both upper and lower splint or to first restore occlusion in at least one jaw with prosthetic reconstruction.

In case of significantly increased incisor overjet, as in case of severe Angle Class II, an occlusal splint on the maxillary arch is preferred because it is difficult to achieve proper anterior contacts and guidance with a mandibular splint.

In case of a deep curve of Spee, mandibular splint is preferred. Mandibular occlusal splint also offers the advantage of encouraging a better rest place for tongue (which is anterior palate).

Extensions on the facial surfaces of the incisors should be avoided. Besides not being aesthetic, it may prevent adequate lip seal.

**DURATION OF USAGE**

Most patients use their splints only during sleep to protect them from the effects of involuntary parafunctional motor activities like bruxing, clenching, tongue pressure, etc. Those who cannot control such habits when awake may need to use the splint during the daytime hours. There are no fixed rules for the length of time that a conservative splint (a splint that doesn’t change the jaw relations except for a minimal increase of vertical) should be used. Some patients can discard them after a few months, others may need to continue them for decades. Generally wearing must not exceed a few months because with his parafunctional habits, the patient gets used to occlusal splint and a negative dependence can be created. If the patient is aware that their TMD are correlated with stressful situation such as examination or sporting events, episodic daytime wearing is advisable during these periods. In patient with frequent parafunctional habits which abrade their teeth or put in danger their prosthetic reconstructions or implants, permanent nocturnal wearing of the occlusal splint is recommended.

Splints that do not cover all teeth with balanced contacts with opposing teeth...
should not be used for longer period than 4-6 weeks. During that period they should be continuously worn for 24hrs a day and removed only when brushing the teeth. Irreversible changes may occur in the occlusion if they are used for periods longer than 6 weeks. Anterior bite splints are worn continuously but for a very limited time, wearing it for more than 2 weeks may be hazardous in case intracapsular pathology because of compression risk. It is proposed for emergency treatment, or very short duration and musculorarticular symptoms of an acute form. Hard splints cannot be used in the children for more than short periods because they may not fit after a relatively short time and therefore interfere with the normal growth pattern.

The effective monitoring of the patients by the practitioner at 2,4,8 and possibly sometimes 12 weeks is essential to accompany rehabilitation and to evaluate the affect of treatment. Dylina TJ has suggested a protocol, which include adjustments at 24hrs, 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, then interval between adjustments can be extended. Regular supervision is important and a splint should never be delivered without securing that the patient can and will come back for regular check-ups. The dentist also has to ensure that he or she is able to see the patient any working day during the first weeks after delivery. Acute pain can be caused by inflammation in intracapsular TMJ tissues. They may swell or shrink during different stages of the disease period. Repeated adjustments may have to be made for quite long periods. The worsening symptoms require immediate revaluation in order to provide explanations, corrections or necessary adjustment but also revaluation of the diagnosis.

CONCLUSION
Occlusal splint therapy has been used for many years for the diagnosis and treatment of various disorders of the masticatory system. Many designs are described in the literature. The different types of splint are used to treat different conditions. A proper examination and differential diagnosis is necessary to lead to a decision regarding the appropriate role of splint therapy for each problem. After reading this article, clinicians should be better equipped to successfully implement splint therapy into their armamentarium of treatment options in managing masticatory system disorders.

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