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Occlusal splints

Dr. Saloni Dalal[1], Dr. Omkar Shetty[2], Dr. Gaurang Mistry[3]
[1](Department of Prosthodontixs, D.Y.Patil University- School of Dentisrty, India)
[2](Department of Prosthodontixs, D.Y.Patil University- School of Dentisrty,India)
[3](Department of Prosthodontixs, D.Y.Patil University- School of Dentisrty, India)

Abstract:*Occlusal splints alone or in combination with other treatmentmodalities are efficacious in the management of pain in patients with temporomandibulardisorders.Splint therapy is a proven modality for alleviating the pain of many types of temporomandibulardisorders and bruxism. The goal of this article is to review the basic principles of occlusal splinttherapy for treating temporomandibular disorder (TMD), bruxism, and toreview the basic splint designs and explain how to use these effectively.*

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I. Introduction

Occlusal splint therapy has been used for many years for the diagnosis and treatment of various disorders of the masticatory system. It is recommended in oral para function, unstable occlusion, stress related pain symptoms, occlusal interferences, and in extensive restorative treatment.

Splint therapy may be defined as the art and science of establishing neuromuscular harmony in the masticatory system and creating a mechanical disadvantage for parafunctional forces with removable appliances.[1] A properly constructed splint supports a harmonious relation among the muscles of mastication, disk assemblies, joints, ligaments, bones, teeth, and tendons. It is a proven modality for alleviating the pain of many types of temporomandibular disorders and bruxism. It is relatively simple, reversible and non-invasive; it has a low cost as compared with other treatments.

Occlusal splint[2] (GPT-9) is defined as any removable artificial occlusal surface affecting the relationship of the mandible to the maxillae used for diagnosis or therapy; uses of this device may include, but are not limited to, occlusal stabilization for treatment of temporomandibular disorders, diagnostic overlay prior to extensive intervention, radiation therapy, occlusal positioning, and prevention of wear of the dentition or damage to brittle restorative materials such as dental porcelain.

Occlusal splints have the following functions[1]: (1) to relax the muscles, (2) to allow the condyle to seat in CR, (3) to provide diagnostic information, (4) to protect teeth and associated structures from bruxism, and (5) to reduce cellular hypoxia levels.

Relaxing the muscles:

Hyperactivity of the lateral pterygoid muscle is caused by tooth interferences to the centric relation arc of closure[3]; posterior tooth interferences during excursive mandibular movements cause hyperactivity of the elevator muscles[4]; and the elimination of posterior excursive contacts by anterior guidance significantly reduces elevator muscle hyperactivity. It follows that a splint with equal-intensity contacts on all of the teeth, with immediate disocclusion of all posterior teeth by the anterior teeth and condylar guidance in all movements, will relax the elevator muscles providing neuromuscular harmony. The literature reveals that very small (50 μm) occlusal interferences can cause changes in coordinated muscle activity.[5] A muscle that is fatigued through ongoing muscle hyperactivity can present with pain. The pain caused by this activity usually will disappear if the hyperactivity of the muscle is stopped.[6]

Occlusal splints are a means of reversibly altering the occlusion to reduce masticatory muscle activity. Okeson et al. found that acute or chronic symptoms of muscle hyperactivity were lessened significantly with 24-hour splint wear. Fuchs reported the advantages of splint therapy in the reduction of nocturnal EMG masseter activity in patients with temporomandibular disorder (TMD).[7] Beard and Clayton also reported reductions in muscle symptoms with splint therapy.[8]

Allowing the condyle to seat in centric relation:

For the condyle to completely seat under the disk in this centric relation position, the lateral pterygoid must completely relax because of its attachment to the disk through the superior belly. If this muscle stays hyperactive, the disk will be pulled anteromedially and will not seat completely over the condyle. When the disk is loaded in a power bite or through parafunctional activities, the disk, attached muscle, condylar head, condylar

ligaments, and retrodiscal tissues can sustain excess force loads and be damaged if the condyle/disk assembly is not properly related to the fossa. Chronic and acute overloading of the condyle/disk assembly when it is out of its normal physiologic position contributes greatly to temporomandibular *disorder*. Temporomandibular joints are load bearing and susceptible to overload.[9]

Centric relation is the optimal arrangement of joint, disk, and muscle. Splint therapy must use centric relation as the ultimate treatment position except in situations where inflammation of the retrodiscal tissues of the joint makes this position uncomfortable. The patient may use an anteroinferior condylar position until the inflammation subsides (approximately 7 days) and be reintroduced to the centric relation position before permanent changes in the muscle, disk, or supporting tissues take place.

Providing diagnostic information:

Splint therapy can be an important diagnostic tool to determine wear patterns, bruxism habits, and TMD status. Holmgren et al.[10] conducted a study and found isometric clenching in 13% of subjects, bilateral mandibular clenching in 71%, unilateral excursion in 13%, and protrusive movements in 3% through the indentations on splints. Information gained from wear patterns on splints helps determine occlusal configurations, material choice, cusp heights and shapes, guidance angulations, axial loads, the envelope of function, and the neutral zone.

Occlusal appliances are helpful in diagnosing if the pain is due to an extracapsular disorder (occluso-muscular pain) or intracapsular disorder.

Protecting teeth and associated structures from bruxism:

Patients who are prone to nocturnal bruxism should routinely wear occlusal splints at night because the splints protect the teeth against wear as the wear occurs against the splint. Also, the splints reduce stresses on the individual tooth due to more teeth contacts of equal intensity. Occlusal splints do not prevent bruxism, but they distribute the force across the masticatory system. These appliances can decrease the frequency but not the intensity of the bruxing episodes. Literature suggests that bruxism exists in 6.5% to 88% of the population.[11] Gibbs[12] found that the highest recorded bite force during bruxism was 975 lbs. and that bite strength in some bruxer-clenchers can be as much as 6 times that of the non-bruxer. The average maximum biting force measured during clenching is 162 lbs.[13] This data indicates why the forces generated during night activity can destroy the dentition.

Reducing cellular hypoxia levels:

When capillary perfusion pressure is above 25mm Hg cellular hypoxia can take place. When the patient clenches without the splint, pressure may exceed 200 mm Hg, but pressure remains less than 25 mm Hg when clenching is with the splint. With compression of the vessels, the affected area has reduced blood flow, which adversely affects normal function and wound healing.[14]

II. Types Of Occlusal Splints

The occlusal splints[15,16] used most frequently are (1) the permissive splint and (2) directive splint. The permissive (stabilization) splint is sometimes called a muscle relaxation appliance because it is primarily used to reduce muscle pain. The directive (anterior positioning splint) is sometimes called an *orthopaedic repositioning appliance* because its goal is to change the position of the mandible in relationship to the cranium.

PERMISSIVE SPLINT

Permissive splint[17] is an inter-occlusal appliance that provides an occlusal relationship in the masticatory system that is considered optimal. When it is in place, the condyles are in their most musculo-skeletally stable position, at the same time the teeth are contacting evenly and simultaneously. Canine disclusion of the posterior teeth during eccentric movement is also provided.

The treatment goal of the splint is to eliminate the malocclusion that contributes to the presence of the temporomandibular joint disorder. In many patient's reduction of the occlusal factor will lower the overall effect of malocclusion and emotional stress to a level below the patients' physiologic tolerance, thus reducing parafunctional activity and the symptoms. The permissive splints allow the teeth to glide unhindered over the biting or contact surface. When this condition is achieved the neuromuscular reflex that controls the closing of the jaw in maximum intercuspation position is lost. Hence these splints are also called as "muscles deprogrammer". The two classic designs of permissive splints are anterior midpoint contact splints and full contact splints.

Indications:
1. Treatment for masticatory dysfunction signs and symptoms such as muscular pain, TMJ pain, clicking, crepitus, limitation of motion and in-coordination of movements.
2. To treat muscle hyperactivity.
3. Patients with myospasms and myositis.

Anterior Midpoint Contact Splints

Anterior midpoint contact permissive splints are designed to disengage all teeth except incisors[19]. Becker[20] has shown through EMG studies that molar contact allows 100% clenching force; cuspid contact permits approximately 60% maximum clenching force; and incisor contact minimizes elevator muscle clenching force to 20% to 30% of maximum clenching force. Therefore, muscle clenching forces are reduced significantly when contact is isolated exclusively on the incisors. The width of the midpoint contacting platform is limited to the width of the two lower incisors, measuring 8-10mm. Anterior midpoint contact permissive splints include nociceptive trigeminal inhibition(NTI) splint and Lucia Jig

Full Contact Splints

Full contact splints create uniform contacts on all teeth when the joints are fully seated by the elevator muscles or manually by the clinician. Dawson's bimanual manipulation technique[16] is used to seat the joints when adjusting the splint occlusion in CR. In excursive movements, only the anterior teeth touch, to reduce elevator muscle activity. A smooth, shallow cuspid to cuspid ramp is designed to provide anterior guidance, which provides horizontal freedom of movement as well as immediate disocclusion of all posterior teeth. The benefits of such splints include elimination of discrepancies between centric relation and maximal intercuspation; provide large surface area of shared biting force and gives idealized functional occlusion.

DIRECTIVE SPLINT

The directive splint[21] is an inter-occlusal appliance that directs the mandible to assume a more anterior position to centric occlusion when a painful joint problem is present. This position is an attempt to provide a more favourable 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 directive splints have ramps or indentations that limit the movement of the mandible. These include an anterior repositioning appliance (MORA). The aim of providing an anterior repositioning splint is to maintain the mandible in a temporary therapeutic position in which click is eliminated and thereby allowing the disc to reposition. Once the function is again optimal, treatment consists of gradually eliminating the splint and returning the patient to pre-existent normal condition. Examples include an anterior repositioning appliance, a mandibular orthotic repositioning appliance

Indications: (10 Bold)
1. To treat disc-interference disorders.
2. Patients with joint sounds such as single or reciprocal clicks.
3. Intermediate or chronic locking of the joint.
4. Inflammatory disorders (retrodiscal).

While a study by Mona[22] in 2004, showed through, both anterior repositioning splint and the canine protected splint were effective in eliminating pain and clicking in patients with anterior disc displacement with reduction. MRI measurements showed that the canine protected splint was superior to the anterior repositioning splint, as it allowed the articular disc to resume its normal length and shape while moving in a posterior direction during recapture. Disc recapture was demonstrated via MRI in 25% of the subjects from the anterior repositioning splint group, in 40% of the subjects from the canine protected splint group, and in 33.3% of the subjects from both groups

III. Clinical Usage Of Various Splints

A. Permissive Splints

Anterior midpoint contact splints

Bite plane therapy may be used when a muscle disorder is suspected. Bite planes separate the teeth, allowing the muscles to relax. These appliances should not be worn for longer than 24-48 hrs continually, as they cover the maxillary anterior and may cause supra eruption of posterior teeth due to lack of contact.[1] This is also referred to as relaxation plate or Sved plate in which only anterior teeth make contact. It is not recommended if the patient has acute pain in the TMJ or feels pain or soreness at palpation of those areas. It is

mainly recommended in patients with acute or chronic muscle pain if the plane splint is without effect. It should only be used during night time and not more than 10-12 hrs/day.

Bite splint with a pivot was introduced by Krogh-Poulsen[23] and was supposed to be helpful in patients with disk displacement. The proposed effect is that the condyles are pulled downwards upon clenching on the pivot, thereby relieving traumatic load and giving the disk freedom to reassume a normal position. The contact in these splints is usually on most posterior tooth.

Full Contact Splints

Stabilization splints are commonly used for treatment of masticatory dysfunction signs and symptoms such as muscular pain, TMJ pain, clicking, crepitus, and limitation of motion and in coordination of movement.

Carrarro and Caffesse[24] described the response of 170 TMD patients treated only with a full coverage stabilization splint. The splints were worn full time, except for eating and covered the maxillary or mandibular dental arches. 82% of subjects responded favourably to the splint therapy. Symptoms of TMJ pain, muscle pain or dysfunction all improved. Clicking was the most difficult dysfunctional symptom to eliminate.

Thirty-three patients selected from a TMJ clinic population seeking treatment for pain, where the muscle and joint pain could be elicited by palpation, were evaluated by Okeson[25]. They were treated for one month with a maxillary stabilization splint. 28 of 33 (85%) showed a decrease in observable pain scores.

The choice of arch for which the splint is fabricated is dictated by the type of bruxism habit. If the patient clenches isomerically, a full coverage maxillary guard with all of the teeth in contact is appropriate. With isometric clenching, the maxillary anterior teeth would not be covered on a mandibular splint, and since no movement takes place, this force would not be properly distributed using the type of the splint. If the patient demonstrates parafunctional movement in lateral and protrusive directions, a splint for mandibular teeth will be effective.[1] According to Wilkerson, lower splints have certain advantages that make them a favourite for many experienced clinicians. These include lower visibility, fewer speech changes, shallower anterior ramps and better patient compliance when instructed to wear their splints during the day as well as at bed time.

B. Directive splints

The anterior repositioning appliance alters the maxillomandibular relationship so that the mandible assumes a more anterior position. Originally, this type of appliance was supposed to be used to treat patients with internal derangements (usually anterior disk displacements with reduction)[26]. Currently, it is recommended that this should be used primarily as a temporary therapeutic measure to allow for symptomatic control of painful internal derangements, but not to "permanently" recapture the TMJ disc. This type of appliance should be used with discretion, and only for short periods of time.[27]

Advanced disc and muscle disorders are identified in patients who experience jaw looking and/or noises painful joints, and sometimes increasing pain with splint wear. Patients with acute trauma may require an anterior repositioning appliance for 7-10 days to keep the condyle away from the retrodiscal tissues, so inflammation can subside.[1] In a sample of patients with painful clicking on opening, closing or both, Tallents et al.[28] described the results of examination with arthrograms and arthrotomograms in 141 joints and reported that not all clicking patients are candidates for repositioning therapy and that clicking is not always caused by a displaced disc.

Okeson[29] took a retrospective look at 40 patients treated for eight weeks with anterior repositioning splints. All patients had a primary diagnosis of a disc interference disorder: The success rate was 25% if the patients were free of pain, clicking and locking. Accepting painless joint sounds, the success rate was 55%. 75% were successful if only pain resolution was considered and 80% were better according to the patient. Therefore, if resolution of pain is the primary objective, repositioning has a good long term prognosis. If elimination of all signs of dysfunction is the goal, repositioning splint therapy is of limited value.

Naikmasur[30] concluded in a study that occlusal splint therapy has better long term results in reducing the symptoms of MPDS. It has better patient compliance, fewer side effects and is more cost effective than pharmacotherapy; hence it can be chosen for the treatment of patients with MPDS.

IV. Splint materials

Splint Materials The most common material used for fabrication of splints is heat cured acrylics. Splints can also be made in soft materials. Soft rubber splints and hydrostatic splints (Aqualizer) function by separating the teeth. Hydrostatic appliance was designed by Lerman[31] over 30 years ago. In its original form, it consisted of bilateral water filled plastic chambers attached to an acrylic palatal appliance, and the patients posterior teeth would occlude with these chambers. Later this was modified to become a device that could be retained under the upper lip, while the fluid chambers could be positioned between maxillary and mandibular teeth. Aqualizer has flexible fluid layer that equalizes all bite forces by preventing tooth to tooth contact. It has a

unique water system that immediately optimizes biomechanics, supports the jaw in a comfortable position, removes the teeth from dominance, placing bite and body in[32] harmony

Use of hydrostatic splint (Aqualizer) is indicated in TMJ pain, headache, neck and shoulder pain and stiffness, orthodontic triggered muscle pain during treatment, pre-surgical differential diagnosis, post-surgical pain and inflammation. Aqualizer's fluid system responds dynamically, continuously reequilibrating and balancing bilaterally as the mandible shifts to the position most comfortable for the muscles to function.

V. What Splints Cannot Do[16]

Splints cannot do 3 basic things: unload the joint, prevent bruxism, or "heal" the patient. Occlusal splints *do not unload the joints*. A perfectly made occlusal splint can *reduce the compressive load on theTMJs*, but the joints are always under some degree of loading. It is a common misconception to think that increasing the vertical dimension of occlusion distracts the condyles downward in a vertical direction, taking all loading forces off the TMJs and transferring the load to the teeth. The elevator muscles are between the last tooth and the condyles, so there is no way for contraction of the elevator muscles to do anything other than seat the condyles up. Splints do not prevent bruxism; they balance the force distribution to the entire masticatory system. They can decrease the frequency but not the intensity of bruxing episodes. Splints also do not heal patients; they give patients the opportunity to heal themselves.

VI. Summary

Dental practitioners have a responsibility to understand and reinstitute neuromuscular harmony in a compromised masticatory system, monitor the condition, and refer the patient to another practitioner if necessary. Occlusal splint therapy is an effective means of diagnosing and managing temporomandibular disorders, but due to multifactorial etiology, some limitations may be encountered relative to creating long term joint stability.

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