Heal Talk

A-Z of Occlusal Splints in Orthodontics- Part I

Dr. Aparajita Mishra[1], Dr. Shally Mahajan[2], Dr. Ragini Tandon[3], Dr. Ashish Chauhan[4]

MDS[1], Professor[2], Professor & Head[3], Senior Lecturer[4], Dept of Orthodontics & Dentofacial Orthopedics, Saraswati Dental College & Hospital, Lucknow

Abstract

Occlusal splints has been used for decades for the treatment of various disorders of cranio-facial region.This appliance provide the practitioners with a non -invasive, reversible form of intervention to manage the patient's symptoms.It is recommended in oral parafunctional habit, unstable occlusion, stress related pain symptoms, occlusal interferences, and in extensive restorative treatment. A wide variety of designs of occlusal appliances are known to be useful and effective in the treatment. The better knowledge of the effects of splint and its mechanics can speed up the various treatment of the patient .

This article presents a brief idea about the occlusal splint and also puts light on the historical perspective that how occlusal splint came into existence.

Keywords: Occlusal Splint, Orthopaedic device, Parafunctional habit, Occlusion , Neuromuscular function, TMJ disorders

Introduction

An occlusal appliance (often called a splint) is a removable device, usually made of hard acrylic, that fits over the occlusal and incisal surfaces of the teeth in one arch , creating precise occlusal contact bite guard, with the teeth of the opposing arch. It is commonly referred to as a night guard, interocclusal appliance or even an orthopaedic device.[1]

Occlusal splint 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”.[2]

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".

Several types of appliances are used in dentistry. Each aims at affecting a specific causative factor. Splint appliances are gaining importance in orthodontics for their wide range of use. Splint appliances can offer such therapy while temporarily improving the functional relationship of the masticatory system. They protect the teeth and supportive structures from abnormal forces that may create breakdown and or tooth wear. They can also be used to introduce an optimal occlusal condition that reorganises the neuromuscular reflex activity, which in turn reduces abnormal muscle activity while encouraging more normal muscle function.

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.[3]

Occlusal splint therapy is useful for the diagnosis and management of various masticatory system disorders.Acommon reason for prescribing an occlusalsplint is to protect the teeth from excessivewear in patients with bruxism. Splints are alsoused frequently to treat patients with internalderangement and other TMDs with associatedsymptoms, such as tension headache and cervical, neck and oral/facial pain.[4]

A common goal of occlusal splint treatment is to protect the TMJ discs from dysfunctional forces, which may lead to perforations or permanent displacements. Other goals of treatment are to improve jaw-muscle function and to relieve associated pain by creating a stable balanced occlusion.[5]

Most occlusal splints have one primary function: to alter an occlusion so they do not interfere with complete seating of the condyles in centric relation.

This series of articles is an effort to make a dental practitioner/ orthodontist to be familiar with an idea of all the occlusal splints available in a nut shell. Thisarticle introduces the occlusal splint and also involves its historical background ,theories defining its mode of action, functions, indications and contra-indications of the occlusal splints.

Historical Background

The original inventor of the forerunner of modern splints will probably never be known. With the development and patenting of vulcaniterubber in 1855, Charles Goodyear provided dentists with a material that could be molded for many different oral applications. One of the early medical uses of vulcanite was bydental surgeons for splinting of broken jaw bones. In November 1862, Thomas Gunning[6], a practicing surgeon, used vulcanite to fabricate a custom fitting splint to treat himself or a broken jaw. He wore the splint for two months and discarded it when he considered himself healed.

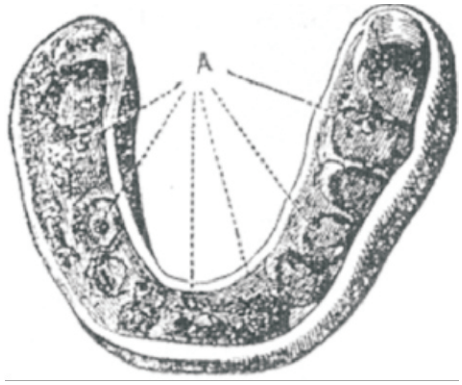

Figure 1. Gunning's custom-fitted splint made from vulcanite

James Bean[7], working independently from Gunning, used a vulcanite device for jaw fractures while in the service of the Confederate Army. His splint had cup-like depressions to fit over the crowns of teeth. The Gunning vulcanite splint (Figure 1) is remarkably similar to appliances used today to treat temporo-mandibular disorders.

In 1887, twenty-five years after Gunning's development, Kingsely[8], published an article discussing the use of soft vulcanized rubber to make an obturator. Then in 1888, Farrar discussed the use of a splint to disarticulate the teeth for the purpose of increasing the eruption of selected teeth. He also recognized the changes in what he calls the inferior maxilla and its articulation.[9]

Occlusal splints were introduced by Karolyi (1901). Almost 100 years ago for treatment of bruxism. Since that time a multitude of various occlusal devices have been proposed for the treatment of occlusal dysfunction as concepts have evolved and changed.

During the first half of this century 'loss of vertical dimension' was perceived to be the main cause of occlusal disorders (Monson, 1921; Goodfriend, 1933) and onlay splints on the posterior teeth were recommended. However, it soon became evident that the onlays resulted in intrusion of the posterior teeth and subsequent closing of the vertical dimension. Later, it was also documented experimentally in monkeys that such onlays lead to slow intrusion of the posterior teeth and elongation of the anterior teeth (Ramfjord & Blankenship, 1981).

Another approach to the increase of the vertical dimension was through appliances for intrusion of anterior teeth and simultaneous extrusion of the posterior teeth by Hawley's (1919) maxillary biteplane, later modified by Sved (1944). These appliances resulted in an unstable, changing occlusion.

An old common misconception was that occlusal dysfunction was caused by a 'distal displacement of the mandible' forcing the condyles into a distal position exerting damaging pressure on the joint structures. This condition was diagnosed radiographically and corrected with biteplanes, splints and restorative dentistry (Sicher, 1948; Lindblom, 1960; Gerber, 1966; Weinberg, 1972).

The 'ideal' vertical dimension and condylar position was established on the basis of transcranial radiographs of the temporo-mandibular joints (TMJ). This concept apparently is not valid (Palla, 1977).

The modern use of biteplanes and occlusal splints to eliminate temporarily occlusal interferences and to allow ideal seating of the

condyles was initiated by Posselt in the 1950s (Posselt, 1955; Posselt, 1963). The appliances were recommended for TMJ and muscular disturbances related to occlusal dysfunction. He used both Sved biteplanes in the maxilla and occlusal splints in the mandible or both in the mandibular and the maxilla. The splint had occlusal contacts of all opposing teeth.

The Sved biteplanes (Figure 2) were used mainly for patients with severe TMJ and muscle pain. The occlusal splints in the mandible were used to eliminate the effect of occlusal interferences and to increase vertical dimension.

Figure 2. Sved Anterior Bite Plane

Later, as the interest for disc displacement in the TMJ became of special concern (Farrar, 1972), the Mandibular Orthopaedic Repo sitioning Appliance (MORA) (Figure 3) was promoted (Gelb, 1985) with controversial results (Dawson, 1989) and posttreatment problems which required extensive therapy.[10]

Figure 3. Gelb's MORA

Theories Supporting the Mode of Action

Occlusal Disengagement Theory

The occlusal disengagement theory is based on the concept that providing the patient with an interocclusal appliance that has an "interference free, ideal occlusal scheme", will reduce or eliminate all abnormal muscle activity caused by occlusal interferences.

The occlusal scheme of splint is usually designed to have simultaneous, bilateral, multiple posterior tooth contacts, with excursive guidance on the canine and/or anterior teeth.[11]

Vertical Dimensional Theory :

The vertical dimension theory is based on the concept that by providing the patient with an inter-occlusal splint designed to restore the previously lost occlusal vertical dimension, abnormal muscle activity due to abnormal vertical dimension will be eliminated or reduced (Block 1947; Christmen 1970). According to this theory, care is given to select an inter-occlusal opening that re-establishes the "original" occlusal vertical dimension.

Maxillomandibular Realignment Theory:

The maxillomandibular realignment theory states that, for various reasons, the mandible in the position of maximum intercuspation has an abnormal, non-adaptive position relative to maxilla. It is theorized that only by changing this relationship to more anatomically and physiologically correct jaw position with an interocclusal appliance will the various dysfunctional musculoskeletal symptoms improve or disappear.[12]

TMJ Repositioning Theory:

This theory explains the functions of repositioning splints. As these splints change the maxilomandibular relation causing relief to the temporomandibular system. But this position should be reconstructed permanently as it is a temporary therapeutic position.

Cognitive Awareness Theory:

This theory can be applied to any or all of the appliances utilized. The cognitive awareness theory is based on the concept that having an inter-occlusal appliance in the mouth constantly reminds the patient to alter his/her normal behaviour so that the opportunity for harmful or abnormal muscle activity with every closure of the teeth is decreased.

The increased cognitive awareness of the patient regarding the positioning and use of the jaw, the change in oral tactile stimuli, and the decrease in oral volume can all influence the patient to learn what position or activities are harmful.

Learning to alter, reduce or change a harmful behaviour is generally helpful to most successful therapeutic interventions (Rugh and Selberg 1976).[13]

Functions

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.[14]

Distribution of forces:

The forces generated during bruxism can be as much as six times the maximal force generated by normal chewing.[10]The splints distribute these forces across the masticatory system. These appliances can decrease the frequency of bruxing episodes but not the intensity.[15]

Mitigation of periodontal ligament proprioception:

Each tooth root is covered by periodontal ligament, this periodontal ligament connects the nerve fibres which receives the stimulation from the biting forces and this message is sent to central nervous system which in turn triggers the muscles to counter the force and protect the teeth and stomatognathic structures from over loading. Splint redistribute the forces by covering over a large surface of teeth. It balances the proprioception and even reduces it. Regular adjustment and modifications of splints are required to obtain uniform contacts and balance.

As per the study done by Hannam et al [16] jaw opening was observed in cats on the stimulation of pressure receptors in periodontal membrane.

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 disocclusion of all posterior teeth by the anterior guidance and condylar guidance in all movements, will relax the elevator and positioning muscles.[17]

Headache is observed in many TMD patients.[18,19] The effectiveness of splint therapy in reducing head and neck pain and muscle hyperactivity is well documented.[16] 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.

Allowing the Condyles to Seat in Centric Relation (CR):

Centric Relation (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 emminentia irrespective of tooth position or vertical dimension."[7]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 belly 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[20] ,specifically during para functional 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 to hyperactivity through occlusal stimuli, the disc is pulled antero-medially 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 temporomandibular disorders.

A properly balanced splint results in an occlusion associated with relaxed positioning 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.

Curtis and coworkers[21] demonstrated that splints designed to provide a lateral deviation to 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.[22]

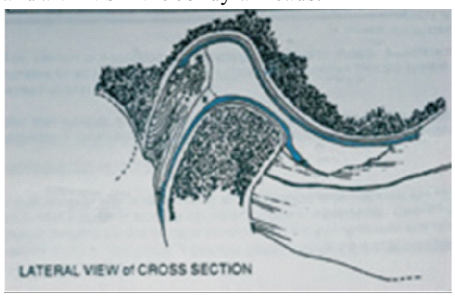

Figure 4. The properly aligned condyle/disc assembly. Physiologic function is dependent on the component parts being in position when loading occurs.

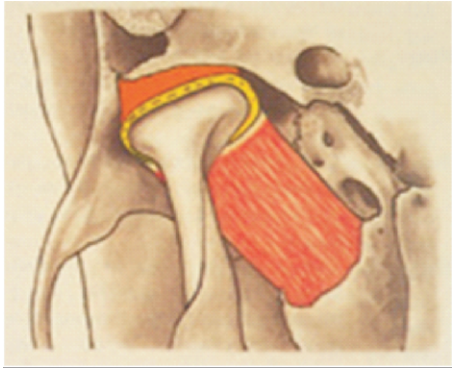

Figure 5. The articular disc and its attachments maintain their physiologic position as the lateral pterygoid obtains full extension.

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 [23]

Initiating factors of facial pain and TMJ disorders (occlusal interferences, bruxism and emotional stress)

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Continuous contraction of muscle fiber without rest

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Excessive consumption of ATP

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Rigor like state

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Muscle spasm

|

Relief of Muscle spasm

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Minimum ATP consumption (prevention of ATP exhaustion)

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Deceleration of cross-bridge cycling Between actin and myosin filaments and decrease in tension

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Increase in vertical dimension (stretching elevator muscles)

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.[3]

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 favourable 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.[3]

Providing diagnostic information

Splint therapy is a useful diagnostic tool for restorative dentistry. Wearing a splint gives the information about the TMD status, bruxism habits and wear pattern. Whenever splint is given to a patient the splints show wear pattern which can be reintroduced in natural dentition after stoping the splint therapy. Different people show different occlusal schemes depending upon the chewing habits which varies with people having horizontal grazing pattern and vertical chopping bite.

A study was done by Holmgrenetal[15] to access the wear pattern in the patient with bruxism by placing hard acrylic resin splints the results revealed the 13% of subjects showed something clenching, 71% subjects showed unilateral excursions and 3% subjects showed protrusive movements. Wear patterns obtained on splints gives information about the envelope of function, neutral zone, axial loads, occlusal configuration, choice of material to be used, cusp heights and shapes and guidance angulations to be introduced in restoration. Splint therapy also reveals the anatomical and physiological status of the TMJ. If the symptoms are rapidly improved it means the problem was muscular. But if the problem worsens with use of permissible splints it can be diagnosed as internal derangement of disc or a wrong diagnosis of the condyle and disc assembly.

Reducing cellular hypoxia levels.

A study done by Nitzan [24] to differentiate the capillary perfusion with and without the use of plane occlusal splint and revealed that without splint the capillary pressure exceeded 200 mm of the whole as the pressure reading with splint was less than 20mmHg. The compensation of vessels leads to reduced blood supply of the affected one and hence affects its healing and normal functioning.

Indications

- Growth modification during mixed dentition
- Limited (tipping) tooth movements desired (arch expansion, individual tooth mal-position) Retention following orthodontic treatment.
- Adjunct to fixed orthodontic appliances.
- Interfere with (or prevent the development of) abnormal orofacial habits.
- TMJ disorders.
- Fractures of the mandible.

Contraindications

- Severe skeletal discrepancy
- Severe rotation-bodily movement neede
- Vertical discrepancy
- Severe crowding
- Very dense bone.

Conclusion

The occlusal splint provides the practitioners with a non-invasive, reversible form of intervention to manage the patient's symptoms. An occlusal device should be stable, comfortable and have a proper occlusion so that the patient can use it consistently to assess the effects of occlusal change.Occlusal splint therapy has been used for many years for the diagnosis and treatment of various disorders of the masticatory system.

The second series of article will elaborate on clinical implication of splints in dentistry including duration of usage .

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