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# OCCLUSAL STABILIZATION SPLINT FOR TEMPOROMANDIBULAR DISORDERS:A REVIEW OF EVIDENCES

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**Abstract**
Temporomandibular Disorders (TMDs) is a collective term that embraces a number of clinical conditions that involve the masticatory musculature and/or temporomandibular joints (TMJs) and associated structures. The symptoms of TMD should be treated at the earliest with conservative therapy. Since the aetiology and inter-relationships of many TMDs are often complex, the initial therapy should be reversible and non-invasive. The Stabilization splint (SS) is a non-invasive and reversible biomechanical device used for managing pain and dysfunction of temporomandibular articulation and its associated musculature, as well as being the most commonly used treatment modality for managing symptoms of TMD. SS is designed to promote occlusal stability and decrease muscles tension. However, their mechanism of action and the precise conditions under which they can be recommended have remained quite controversial. The indications, contraindications, advantages, disadvantages and comparison of SS with other treatment modalities can help to determine its effectiveness for treating TMDs.

**Keywords:** Temporomandibular disorders, Non-invasive, Stabilization splint, Treatment of TMDs

## INTRODUCTION

One of the most difficult challenges that clinicians encounter is chronic pain treatment. These diseases, which are frequently encountered in the head and neck area, account for nearly 40% of all cases seen in large pain clinics. TMDs are the most frequent non-tooth-related chronic orofacial pain problems that dentists and other healthcare providers encounter.[1]

TMD symptoms can be accompanied with substantial morbidity, resulting in severe discomfort and functional limitations. Psychological discomfort, physical incapacity, and orofacial system functional limitations all have a substantial impact on the daily lives of TMD patients. The causes of TMDs are not always evident, nor is it understood if they are caused by joint structures or muscles, which influences decision making in establishing correct diagnosis. There are various etiological variables that may lead to the development of TMDs, either alone or in combination, although they have received little attention. According to the American Association for Dental Research, addressing TMDs should be evidence-based, with the goal of providing therapy with the best potential for long-term symptom reduction. Occlusal oral appliances, pharmaceutical therapy, physical therapy, cognitive-behavioral therapy, counselling, and self-care management, as well as their combinations, can all help to relieve symptoms in the muscles and jaw joints.[2]

## OCCLUSAL APPLIANCES

An Occlusal Appliance (OA) is a hard acrylic removal device that fits over the occlusal and incisal surfaces of one arch's teeth, making exact occlusal contact with the teeth of the opposite arch (Figure 1). It's also known as an occlusal splint, bite guard, night guard, interocclusal appliance, or orthopaedic device (orthotic).

OAs have numerous applications, one of which is to provide a stable occlusal state that can modify peripheral sensory input to the Central Nervous System, resulting in improvements in specific muscular pain disorders and joint position.[3] Because the origin and interrelationships of numerous TMDs are frequently complex, the initial therapy should be reversible and non-invasive in most cases. OAs can offer such therapy while temporarily improving the functional relationships of the masticatory system.

Types of Occlusal Appliances

A) Types of OAs according to Okeson[3] are:

1. Stabilization appliance/ Muscle relaxation appliance
2. Anterior repositioning appliances
3. Anterior bite plane
4. Posterior bite plane
5. Pivoting appliance
6. Soft/resilient appliance

B) According to Dawson[4]:

1. Permissive splints/ muscle deprogrammer
2. Non-permissive splints /Directive splints
3. Pseudo permissive splints (e.g. Soft splints, Hydrostatic splint)

Hypothesis for efficacy of Occlusal Appliances

1) Dental reasons
1. Alteration of the occlusal condition
2. Alteration of the condylar position
3. Increase in the vertical dimension

2) Non dental reasons
1. Cognitive awareness
2. Placebo effect
3. Increased peripheral input to the CNS decreases motor activity
4. Regression to the mean (natural fluctuation of symptoms)[3]

Materials for fabrication of Occlusal appliances

1. Hard acrylic resin OAs: chemically cured or heat/pressure processed.
2. Soft or resilient OAs manufactured from plastics or polymers.
3. Dual laminated: hard acrylic resin on the occlusal surface and a soft material on the inner aspect (tooth-borne surface)

## STABILIZATION APPLIANCE

Description and Treatment Goals

Michigan splints, Tanner appliances, Fox appliances, and centric relation appliances are all names for stabilisation splints. The choice of splint should be based mostly on whatever type will be most comfortable to wear and least noticeable in terms of appearance.[5] The treatment goal of the stabilization splint as outlined by the American Academy of Orofacial pain guidelines are:

1. Provide joint stabilization
2. Protect the teeth
3. Redistribute the [occlusal] forces
4. Relax the elevator muscles
5. Decrease bruxism
6. Increases the patient's awareness

Indications

1. The SS is most effective for masticatory myalgia and TMJ arthralgia, particularly when the discomfort is severe on awakening.
2. To treat myospasms or myositis produced by hyperactive muscles. It reduces the activation of parafunctional muscles.
3. In joint pathology, for the regulation of overload on structures caused by bruxism when sleeping or awake.
4. To alleviate symptoms related with parafunctional activities and higher levels of emotional stress.
5. Individuals suffering from retrodiscitis as a result of trauma.
6. When stresses on injured tissues must be reduced to allow for optimal healing.
7.To promote favourable joint remodelling, inflammation reduction, and condylar recorticalization in individuals with osteoarthritis related or not with disc displacement without decrease.[6]

Contraindications

1. When firm load testing reveals no signs of pain or tension and there is no history of complaints. [4]
2. Individuals with morning intermittent locking or minor symptomatic disc displacement with no decrease that can promote or inhibit its advancement. [6]
3. Patients with short-term disc displacement without reduction who are candidates for recapturing (an anterior replacement splint will be indicated). [7]
4. The use of a splint in patients with apnoea-hypopnoea syndrome is debatable, because the association between splint and apnoea improvement is not yet established, and bouts of apnoea may worsen in patients for whom bruxism may operate as a protective factor.[8,9]
5. When a distracting condyle or rotating on molar contacts is required to unload the TMJ.
6. When muscles must be restrained in order to be less active once the splint is removed.
7. When headache conditions of largely neurovascular or vascular origin must be treated.
8. Recapture misplaced discs, improve retrodiscal tissue repair, and avoid the transition of anterior disc displacement with reduction to anterior disc displacement without reduction.
9. Achieve the "perfect" neuromuscular/occlusal connection.
10. Reduce or stop sleep bruxism behaviours permanently.
11. Determine the "proper" vertical occlusion dimension.[5]

Advantages

1. Prevent the patient from closing in the maximal intercuspal position: The occlusal splint forces the patient to adopt a new posture, resulting in a new muscle and articular balance.
2. Force distribution: The forces created during bruxism can be up to 6 times greater than the maximal force generated by regular chewing. These stresses are dispersed by the splints throughout the masticatory system.
3. Normalizing periodontal ligament proprioception: An occlusal splint dissipates stresses imposed on individual teeth by covering all teeth in the arch with a larger surface area. As a result, a splint balances the load and allows for muscular symmetry.
4. Relaxing the muscles: A splint with similar intensity contacts on all teeth, with immediate disclusion of all posterior teeth by anterior and condylar direction in all movements, will relax the elevator and positioning muscles.
5. Enabling the condyles to sit centrically: A well balanced splint results in an occlusion associated with relaxed posture and elevator muscles, allowing the articulator disc to obtain its antero-superior position above the condylar head.
6. Increase in the vertical dimension of occlusion: Using an occlusal splint to lengthen elevator muscles to or near the vertical dimension of least electromyographic activity is useful in generating neuromuscular relaxation.
7. Cognitive awareness theory: Having an interocclusal appliance in the mouth constantly reminds the patient to change his/her typical behaviour, reducing the possibility of damaging or abnormal muscle activation with each tooth closure.
8. Increase the patient's subjective jaw opening in circumstances where range of motion is limited due to a muscular issue.[10]

Disadvantages

1. Anterior open bite
2. Molar intrusion with accompanying posterior open bite, in full time users of stabilization splints.
3. Psychological dependence
4. Stabilization splints used for the treatment of anteromedial disk displacement with reduction may rarely cause locking.
5. Worsening of Apnoea-Hypopnoea Index and Respiratory Disturbance Index in patients with obstructive sleep apnoea.
6. Alteration of cervical postural tone at rest and during swallowing.
7. Most serious known risk, which occurs infrequently, is the appearance of irreversible occlusal changes, which can also develop with part-time splint usage.
8. In terms of maintenance and oral habits of the patient, caries and gingivitis.[11]

Fabrication Of Occlusal Stabilization Splint

Although the full-arch hard acrylic stabilising device can be used in either arch, there are some advantages to using it in the maxillary arch. The maxillary device is more retentive and less likely to break since it is more stable and covers more tissue. It's also more flexible, with opposing interactions possible in any skeletal or molar link. Another feature of the maxillary appliance is its ability to assist in locating the musculoskeletally stable attachment of the condyles in the fossae.

The main benefits of the mandibular appliance are that it allows the patient to talk more easily and is less apparent for some patients (thus more aesthetic). However, this advantage is only present if the patient needs to wear the appliance during the day.[12]

Several fabrication techniques have been described in an attempt to improve dimensional stability, including:

1. CAD/CAM assisted fabrication of stabilization splint.[13]
2. Use of autopolymerizing acrylic resin in a doughy stage.[14]
3. Use of autopolymerising acrylic resin at 100◦F under pressure.[15,16]
4. Fabrication of the occlusal device on the articulated models with heat-cured acrylic resin.[17]
5. Addition of clear autopolymerizing acrylic resin on the occlusal surface of a vacuumadapted resin sheet.[18]
6. Sprinkle-on technique with autopolymerizing acrylic resin.[19]
7. Use of heat-cured acrylic resin after flasking under 3500 pounds of pressure for 10 minutes.[20]

Final Criteria For The Stabilization Appliance

Before the patient is given the stabilising device, the following eight requirements must be met:

1.It must fit the maxillary teeth precisely, with complete stability and retention while contacting the mandibular teeth and when tested by digital palpation. [21]
2. Stable central contact: In the musculoskeletally stable position (CR), all mandibular buccal cusps and incisal edges must make equal force contact on flat surfaces.[17,20,21]
3. Steady protrusive contact: During protrusive movement, the mandibular canines must make even contact with the appliance. The mandibular incisors may also make contact, although not with as much force as the canines.[17,20,21]
4. Steady lateral contacts: Only the mandibular canine should make laterotrusive contact with the device during any lateral movement. [17,20,21]

5. During closure, the mandibular posterior teeth must make somewhat greater contact with the appliance than the front teeth.
6. In the upright "alert feeding" position, the posterior teeth must make more apparent contact with the appliance than the front teeth.
7. The appliance's occlusal surface should be as flat as feasible, with no impressions for mandibular cusps.
22 The occlusal appliance is polished so that it does not hurt the surrounding soft tissues.[3]

Instructions And Adjustments

The patient is shown how to properly insert and remove the device. Finger pressure is initially used to align and seat it. Once on the teeth, it can be held in place with biting power. The easiest way to remove it is to catch it in the first molar area with the index fingernails and pull the distal ends downward.[3] The splint is worn until the following requirements are attained:[4]

1. All related pain is gone
2. The joint structure is stable
3. The bite structure is stable

Salivation may increase at first, but this normally subsides within a few hours. To minimise plaque and calculus buildup and to avoid any unpleasant aftertaste, the appliance should be scrubbed soon after being removed from the mouth (with water, a dentifrice, or perhaps baking soda). The patient can be provided an instruction leaflet on how to care for the occlusal appliance.[3]

Follow Up

As formerly tight and painful muscles relax, the mandible usually shifts somewhat, resulting in a shift in the pattern of occlusal contacts against the splint. To encourage compliance and correct any difficulties with comfort or occlusal alterations, the patient should be examined 1-2 weeks after the splint has been set. The occlusion's stability must be evaluated. The splint must be adjusted to restore the original pattern of even contact, and the patient is scheduled to return in a few weeks. This occlusal monitoring and adjustment routine is repeated until the contacts are stable.[21]

**COMPARISON OF OCCLUSAL STABILIZATION SPLINT WITH OTHER TREATMENT MODALITIES**

The effectiveness of SS therapy in reducing symptoms in patients with TMD can be shown by comparing it with other treatment modalities.

1) SS versus minimal/no treatment

a) Pain outcome

A statistically significant lower pain score can be seen in patients using stabilisation splint using Pain Palpation Index and Pain Severity Scale.[23] A statistically significant difference was also seen when SS was compared to a minimal treatment group in terms of change in present pain and pain on palpation measured using a Visual Analogue Scale.[24] However, some authors found no significant difference was shown when SS was compared to a passive control group in terms of improvement in intensity of pain at rest.[25,26]

Johansson (1991) compared SS with acupuncture and a non-intervention control group. Both of the treatment groups showed a statistically significant improvement in pain post treatment compared to the non-treatment group.[27]

b) Depression Outcome

Reduction in depression levels can be seen in patients using SS compared to no treatment group.[23]

c)Reciprocal click

No statistically significant difference can be seen when SS is compared to a no treatment group in terms of reciprocal clicking.[26]

2) SS versus non-occluding splints

a) Pain outcome

No statistically significant difference can be seen between SS and non-occluding splints in terms of unpleasantness and intensity of pain, number of painful muscles on palpation and pain diary score.[25,28,29]

Studies by Ekberg *et al*. (1998), Raphael *et al*. (2001), and Conti *et al*. (2006) found that stabilization appliances worn part-time while sleeping were better than the non-occluding appliances, taking into account pain outcomes.[28,30,31] In contrast, studies by Dao *et al*. (1994), Rubinoff *et al*. (1987) and Wassell *et al*. (2004) used appliances full-time (24 hours) and reported no difference relative to non-occluding appliances at 6 to 10 weeks of followup.[25,29,32] The meta-analysis by Fricton *et al*. (2010) yielded a benefit in favour of the hard stabilization appliances when compared to the non-occluding appliances.[33]

b) Mandibular movement outcome

There was no statistically significant difference in the increase in maximal opening (mm) between groups receiving SS or a non-occluding splint.[29]

c) Overall improvement

No statistically significant difference can be seen between SS and non-occluding splints in terms of overall improvement of symptoms and functional outcomes (swallowing, chewing, yawning, drinking, etc.)[28,29]

d) Quality of life

Quality of life can be examined in terms of improvement in sleep, efficiency at work, social activities, feeling depressed, feeling anxious, and poor appetite. A statistically significant difference in favour of SS can be seen for efficiency at work. However, a statistically significant difference in favour of bite plates can be seen for improvement when examining patient's social activities and feeling of depression.[25]

3) SS versus acupuncture

a) Pain outcome

No statistically significant difference can be seen between SS and acupuncture in terms of pain on palpation, pain on retrusion of mandible or jaw opening and severity of pain.[34]

b) Mandibular movement outcome

Raustia (1986) showed a statistically significant difference with regard to deviation to the right side in mouth opening movement after treatment in the SS group when compared with the acupuncture group. There was no statistically significant difference between groups with regard to range of lateral movements.[34]

c) Clicking outcome

No statistically significant difference can be seen between SS and acupuncture in terms of improvement in TMJ click.[34]

d) Dysfunction score

Johansson (1991) assessed the clinical signs by means of the Helkimo clinical dysfunction score. Both SS and acupuncture groups showed a statistically significant decrease in dysfunction score although no between group differences were found.[27]

4) SS versus bite plates

a) Dysfunction score

No statistically significant difference can be seen in the number of patients showing a high Helkimo dysfunction score using SS and bite plates.[35]

b) Electromyographic activity of muscles

Use of splints at night seems to change the integrated electromyographic activity. In the rest position, the activity decreased more after use of the splint than after use of the bite plate.[36]

5) SS versus biofeedback

a) Pain outcome

SS patients had lower pain scores. However, the difference between the two groups is not statistically significant. Similarly, no statistically significant difference can be seen between SS and BF/SM for the reduction in muscle pain severity.[23]

b) Depression

A statistically significant benefit in the BF/SM group was found, when compared with the SS group in depression level.[23]

c) Treatment credibility

No statistically significant difference can be seen regarding the increase in treatment credibility between SS and BF/SM.[23]

d) Dysfunction score

No statistically significant difference can be seen in the number of patients achieving a decrease in the dysfunction score in SS and feedback groups.[37,38]

e) Mandibular movement outcome

Both the SS and visual feedback groups showed statistically significant decrease in their lateral mandibular movement scores.[39]

f) Mouth opening

The maximal mouth opening increased in both treatment groups but significantly so only in the biofeedback group. The differences between the groups, however, is not statistically significant.[38]

6) SS versus jaw exercises

Improvements in all outcomes measured for both groups can be seen. A follow-up questionnaire 1 to 4 years after first clinical assessment showed a lasting treatment effect in most patients, although many patients continued to perform their jaw exercises or wear their occlusal splint. No statistically significant differences were observed between the groups at any time point.[40]

7) SS versus relaxation

There is conflicting evidence with regard to the effectiveness of SS in comparison to relaxation.

a) Pain outcome

Two trials compared SS with relaxation. Both studies assessed reduction in pain and changes in the maximal mouth opening. Okeson (1983) showed a statistically significant reduction in pain on palpation in favour of SS,[41] however, this was not supported by the trial by Winocur (2002).[24] Significant statistical heterogeneity was found between the two trials for reduction of pain on palpation.

b) Mandibular movement outcome

For changes in maximal mouth opening, significant heterogeneity was found between the two studies both for active/ comfortable opening and assisted/painful opening. Okeson (1983) found a statistically significant difference in favour of SS,[41] but these results were not supported by Winocur (2002). [24]

8) SS versus Anterior repositioning device

Anderson *et al*. (1985) compared anterior positioning appliances to SS for management of pain due to TMJ disc displacement with reduction and found anterior positioning appliances more effective in reducing jaw pain, joint noises, and locking.[42] Tecco *et al*. (2004)found anterior repositioning splint to be more effective than stabilization splint in the treatment of joint pain associated with recently occurring internal derangement.[43]

9) SS versus Occlusal adjustments

Wenneberg *et al*. (1988) compared the use of SS to occlusal adjustment and concluded that appliances were more effective than occlusal adjustment.[44] Yuasa *et al.* (2013) recommended against occlusal adjustments as a primary treatment for TMD.[32]

10) Conventional SS versus CAD/CAM splint

a) Mouth opening

No significant difference can be seen among these two groups between the right and left condyles in the total mandibular opening movements in either of the three planes.[45]

b) Improvement of symptoms

The pain symptoms (headaches, face pain, jaw joint pain, mastication pain and neck pain) and TMJ related symptoms (jaw joint noises, limitation in mouth opening and mastication compliant) improved earlier in conventional SS group than in CAD/CAM splint group.[45]

11) SS versus Pharmacotherapy

a) Sleep variables

Sleep efficiency and Non REM sleep stage III in participants treated with gabapentin were significantly greater than patients who received a stabilization splint while Non REM sleep stage II was higher in the splint group.[46]

b) Bruxism variables

The percentage of bruxism episodes in the supine sleep position was greater in the gabapentin group, however, other parameters did not show significant differences between the two groups.[46]

c) Tension type headache

Schokker *et al*. (1990) found that SS were more beneficial for reducing headache intensity, frequency, and amount of medication needed to control headache compared to standard headache medication management that included muscle relaxants and antidepressants.[47]

12) SS versus Botulinum toxin

a) Pain outcome

A statistically significant difference can be seen between both groups according to Visual analogue scale with more pain relief in the botulinum group than in SS group.[48]

b) Jaw function

A statistically significant difference can be seen between both groups according to Jaw function limitation scale with more increase in movement in the botulinum group than in SS group.[48]

13) Stabilisation splint versus Low level laser therapy

No significant difference between Laser (1,064 nm, 8 j/cm2, 250 mW output power) and Stabilisation groups can be seen after treatment for decreasing myofascial pain (Fig 5.1).[49]

14) SS versus transcutaneous electric nerve Stimulation (TENS)

a) Pain outcome

No significant difference can be seen between SS and TENS groups in terms of pain reduction although both did reduce severity of pain.[50]

b) Functional symptoms With the exception of improved chewing for the TENS group, the functional symptoms and symptoms at rest showed no statistically significant difference between the groups.[50]

c) Mandibular movement outcome

The mandibular range of movement improved in the groups but without significant differences.50

15) SS versus Nociceptive Trigeminal Inhibition–tension suppression system (NTI)

a) Mouth opening No statistical differences were recorded between the two splint type groups in terms of jaw opening which increased gradually in both groups.[51]

b) Pain outcome Self-reported headache and TMD-related pain decreases on average in both splint type groups, however no statistical differences between the two splint groups can be recorded for these two outcomes.[51]

c) Jaw muscle tenderness The average total muscle tenderness following palpation can be seen decreasing significantly in both splint groups with no statistical differences recorded between the two splint type groups.[51] Overall NTI (Figure 2) was found to be less effective than the SS in the treatment of TMDs.[52]

16) SS versus Anterior midline point stop device (AMPS)

Both groups showed significant reduction in pain. Although more reduction of pain appears with the AMPS device (Figure 3), this was statistically insignificant.[53]

17) Effective duration for Stabilization Splint wear

Davies and Gray (1997) studied appliance use 24 hours per day, during the day only, or during the night only. There were no significant differences on pain outcomes among groups, suggesting that the efficacy of appliances is similar whether their use is part time or fulltime.[54] On the contrary Pficer *et al*. (2017) stated that the effect of SS was better in patients in which splint was present for 24 hours than in patients who used it only during the night.[2]

**CLINICAL SIGNIFICANCE**

The placebo response is influenced by the patients' cognitive anticipation, or belief that the treatment will be successful. In fact, the effect of expectation fulfilment can be so powerful that it can override the active medication's true pharmacological effect. Some studies suggests that's occlusal appliances, when used for TMDs, work as behavioural interventions and not as medical devices that produce effects via physical changes in the position of the mandible. Occlusal appliances clearly work better than a wait-list control but not better than a credible placebo therapy, which is itself a nonspecific behavioural therapy. The behavioural effect of an occlusal appliance likely is the result of jaw function changes induced by wearing a device.

As a result, there is inadequate evidence for or against the utility of stabilising splint therapy in the treatment of temporomandibular myofascial pain when compared to other active therapies. When compared to no treatment, stabilizing splint therapy appears to be useful for reducing pain severity at rest and on palpation, as well as depression.

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**FIGURES**

**Figure 1:** Maxillary occlusal appliance.

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**Figure 2:** NTI splint

**Figure 3**: The AMPS device fitted on the 2 upper central incisors