

Temporomandibular Joint Disorders: Diagnosis and Systematic Review on Efficacy of the Different Types of Occlusal Splints in Their Conservative Management

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Abstract:

Chronic orofacial pain due to Temporomandibular Joint (TMJ) dysfunction is a commonly encountered clinical situation by dentists and other health care workers. The symptoms of TMJ disorders may vary from simple headaches, ear pain, bite problems, clicking sounds, locked jaws to severe psychological issue that can affect quality of life for the patient. This article embodies a review of anatomy of the jaw, symptoms, causes, diagnosis and various treatment options of TMJ disorders. This article also evaluates a systematic review on efficacy of different types of occlusal splints in the conservative management of TMJ disorders.

Keywords: Temporomandibular Joint, TMJ Pain, TMJ Disorders.

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Introduction

The stomatognathic system is a functional unit that performs masticatory tasks such as swallowing food, speaking and esthetics. [1] This system includes teeth, supporting tissues, masticatory muscles, nervous system, blood circulation, ligaments, temporomandibular joint (TMJ), lips, cheeks, palates, and tongue. In Temporomandibular joint, the head of condyle of mandible articulates with the glenoid fossa of temporal bone with an interpositioned articular disc. The three main components of stomatognathic system are TMJ, masticatory muscles, and dental occlusion, which in turn are interdependent and coordinated by the central nervous system. Abnormal functioning of any one component results in TMJ dysfunction.

TMJ disorders include a variety of conditions that cause tenderness and pain in the temporomandibular joint (TMJ) with pain as one of the most common complaint. [2] The TMJ and its controlling muscles pose a tremendous challenge to both patients and health care providers when problems arise because of its complex movement and unique makeup. The temporomandibular joint (TMJ) is called a diarthrodial joint because of 2 interdependent joint cavities. The combination of hinge and sliding motions makes this joint most complicated and different from the body's other joints.

The TMJ is the only joint influenced by many external factors such as speech, occlusion chewing (function and parafunction) and/or disease in the oral cavity, and perioral structures. Trauma and psychological factors that cause strain and spasm of the perioral muscles can also result in dysfunction and pain of the TMJ. The complexity of the TMJ and its interrelation with the perioral structures has caused vagueness in understanding the nature, mechanism and treatment concepts for the TMJ disorders.

Anatomy and Biomechanics of the Temporomandibular Joint: An articular disc divides the joint space between the mandibular condyle and the glenoid fossa into upper and lower compartments. The rotatory movements occur in the lower compartment, while the translatory movement takes place the upper compartment. These movements are controlled by the muscles, ligaments, and fibrous capsules. The disc which is firmly attached to the condyle moves along with the condyle during translatory and excursive jaw movements. The shape of the disc is such that it fits well onto the condyle. The upper part of a fibrous bilaminar tissue attached to posterior part of the disc. Connects the disc to the posterior part of the glenoid fossa, while the lower part is is vascular and innervated by free ending nerve fibres

predominantly from the auriculotemporal nerve. [3] Wheelock and Mercuri, describes that a distinct thin elastic tissue layer lies beneath the neurovascular layer. [4] Pain in the TMJ may be due to inflammatory changes in the joint space (effusion or haematoma), the fibrous capsule (tear of the tissue), or adjacent structures.

Etiology and Pathophysiology: Etiology of TMJ disorders may any of the following like articular disturbances, inflammatory diseases, condylar displacement, ankylosis, fractures, neoplasia and developmental abnormalities.

Diagnosis: According to Okeson seven keys to diagnose case are history, mandibular restriction, mandibular interference, acute malocclusion, loading of joint, functional manipulation, diagnostic anesthetic blockade. [5]

- a) History: The patient can be encouraged to recall the events that seemed to initiate the symptoms
- b) Mandibular restriction: Restriction of mouth opening and eccentric movements are common findings with both muscle joint and disorders. There is difference in character of the restrictions. If the restriction in mouth opening is due to intracapsular problems, it usually occurs at 25 to 30 mm beyond which the mouth cannot be opened further, by application of light force. If the restriction occurs anywhere during the opening movement then it may be as a result of muscle disorders. These types of restrictions can be reduced by application of mild force which helps in stretching of muscles. For example, a restricted opening of 8 to 10 mm may be most certainly of muscle origin.
- c) Mandibular interference when the mouth is opened: Any deviations or deflection while mouth opening is observed. If the deviation occurs during opening and the jaw returns to midline before 30 to 35 mm of total opening, it may be associated with the disc derangement disorder. If the speed of opening changes the location of the deviation, it may be due to discal movement. If the interincisal distance of the deviation is not altered by speed opening, and if the location of deviation is the same for opening and closing, then a structural incompatibility should be suspected.
- d) Acute malocclusion: Alteration of the occlusal condition may occur secondary to a disorder which will vary according to the involved muscles.
- e) Loading of joint: In a healthy joint if the condyle is positioned in the musculoskeletally stable position and manipulative force is applied there will be any pain. If there is pain in that position then intracapsular source of pain may be suspected.

- f) Functional manipulation: This can be helpful in locating the pain muscle disorders can be rule out if there is no pain on functional manipulation.
- g) Diagnostic anesthetic blockade: Relief of pain on anesthetic blocking of the auriculotemporal nerve suggests an internal disorder.

Comprehensive TMD Evaluation

Comprehensive TMD evaluation involves

- a) Comprehensive history of all jaw, head and neck symptoms and medical history, dental history, personal history, family story and psychological history.
- b) Comprehensive physical evaluation of TMJs, cervical spine, muscles of the jaw, head and neck, neurological-neurovascular structures, teeth, gum and soft tissues.
- c) Psychological evaluation, including a brief interview and testing when indicated.

Signs and Symptoms: Pain or tenderness of jaw is the most common sign and symptom of TMJ disorders. It may also include pain in and around ear, difficulty or discomfort while chewing, aching facial pain, clicking sound or grating sensation during jaw movement, locking of the joint with restricted mouth opening, headache, and uneven bite with premature tooth contact.

Differential Diagnosis: Differential diagnosis of TMD are trigeminal or glossopharyngeal neuralgia, atypical facial neuralgia, CNS lesions, odontogenic pain, neoplasms and otologic pain

Investigations: Investigations for TMD include Radiographs, Arthrography, TMJ arthroscopy, Bone scintigraphy, MRI and Tomography

Conservative, Nonsurgical Treatments: In some cases, the symptoms of a TMJ disorder may get relieved without any treatment. If they persist, one or more conservative, nonsurgical treatments or behavioral interventions to alleviate pain, to correct dental problems that contribute to the disorder, or to change habits that exacerbate symptoms may be advocated.

They include breaking bad tension-related habits, avoiding overuse of jaw muscles, stretching and massage, heat or cold application, anti-inflammatory medications, biteplate, cognitive-behavioral therapy and occlusal adjustment.

Self-Care Practices: There are steps that may be helpful in easing symptoms, such as: eating soft foods, applying ice packs, avoiding extreme mouth opening, learning techniques for relaxing and reducing stress, practicing gentle jaw stretching and relaxing exercises that may help increase jaw movement.

Pain Medications: In certain people, short term use of nonsteroidal anti-inflammatory drugs (NSAIDS), muscle relaxants, or mild anti-anxiety drugs may provide temporary relief from TMJ discomfort.

Occlusal Corrections: Decreased vertical dimension due to several missing teeth or severe attrition of teeth as a result of congenital defects like dentinogenesis imperfecta is considered as one of the cause of TMJ pain. [6] Full mouth oral rehabilitation with corrected vertical dimension of occlusion has shown to reduce the TMJ pain

Oral orthopedic appliances: Oral orthopedic appliances are regularly used in management of TMD. [7] Oral orthopedic appliances are commonly referred to as occlusal splints, orthotics, night guards or bruxism appliances. These appliances are usually made from hard acrylic covering the upper or lower teeth which can be removed by the patient. They are designed for redistribution of the occlusal forces, prevent wear, reduce mobility of teeth, prevent bruxism/clenching, reduce muscle pain and alter structural relationships within the TMJ. [8]

The purpose of prescribing a bite splint is to protect the teeth from excessive attrition in patients with bruxism. They are also recommended in the treatment of patients with internal TMJ derangement and other TMDs with associated pain symptoms, such as tension headache and neck, and facial pain. A objective of bite splint treatment is protection of the TMJ disks from abnormal forces that may lead to perforations or permanent damage. It can also improve jaw-muscle function and create a stable balanced occlusion thereby relieving pain.

The advantage of bite splints is that occlusal changes produced by them are reversible changes. Occlusion, jaw muscles function and TMJ are interrelated and any change in the patient's occlusion will definitely produce some effect on the jaw muscles and the TMJ structures. Hence for maintaining a normal jaw muscle and TMJ function, a stable, balanced occlusion is required

Main types of splints

Conservative splints: Flat plane Stabilization appliance or Michigan type splint. This muscle relaxation appliance is the most commonly used type of stabilization appliance with the least adverse effects. When properly designed and fabricated, this splint is effective as a diagnostic and treatment device. [9] Muscle hyperactivity is reduced, thereby allowing the condyles to occupy a comfortable position that promotes healing of internal TMJ structures. It is usually placed in the maxillary arch covering all the teeth, allowing the cusps and incisal edges of opposing mandibular

teeth to have a balanced, even contacts with the splint during habitual closure (Figure 1 and 2).

Traditional Anterior Bite Plane splints. These appliances are designed to have a horseshoe shaped palatal occlusal table in 6 or 8 anterior maxillary teeth with a palatal-coverage [10]. These appliances prevent clenching of teeth, as posteriors are not engaged in functional or in Para-functional activities [11]. These appliances may cause over eruption of posterior teeth there by correcting the vertical dimension [12]. These splints also help in identifying the best vertical by adjusting a bite splint, before the planning of the permanent restorations in posteriors for correction of decreased vertical dimension.

Anterior Repositioning Appliance (Orthopedic) these appliances are simple modification of the above splint except that an inclined plane is incorporated in lieu to flat bite plane in the anterior region. Repositioning splints guide the mandible into a position different from (mostly anterior to) the habitual one at closing. [13] The purpose is to facilitate repositioning of the TMJ disks and to reduce the load on retrodiscal neural pain-sensitive areas (Figure 4). These splints are indicated for short-term to restore the disk in a normal upper most position. A repositioning splint can also be fixed one termed cap splint. These splints are described as an intermediary between a splint and a fixed restoration. It is useful in reaching a final decision about design before temporary reconstruction, vertical dimension, etc. It is often made in hard acrylic.

Posterior Bite Plane Appliance These splint design consist of a bilateral soft resin table located over the molars and premolars with a palatal connection which creates a disocclusion of the anterior teeth, these splints can be worn 24 hrs without any aesthetic interference. Even though initial discomfort due to palatal plate is reported, gradual increase in use of the splints from 6 hrs to 24 hrs over a period of 2 weeks has reported less discomfort with relief of symptoms of TMJ disorders. These appliances are intended to produce vertical dimension and horizontal maxillomandibular relationship changes. Posterior bite plane appliances are supposed to produce an "ideal" comfortable maxillomandibular relationship, and should be followed by occlusal procedures to maintain that relationship permanently. The major concern reported with this design is that occlusion only on posterior teeth allow over eruption of the anterior teeth or intrusion of the opposing posterior teeth, Combination splints. Missing teeth can easily be replaced by adding artificial teeth to the splint. [14] A Shore splint can function as a temporary partial denture by adding artificial teeth. [15]

Surgical Treatments: If there is no relief for the pain or discomfort of TMJ disorder following nonsurgical treatments, surgical interventions like injection of intra articular corticosteroid drugs, arthrocentesis or surgery may be recommended.

Corticosteroid drugs or Botulinum toxin injection into the masseter and temporalis muscles for TMJ disorders has been reported to produce significant relief in TMJ disorder symptoms. The initially reduced maximum voluntary contraction is reported to have returned to their initial values.

Surgical procedures like Discectomy, High condylectomy and repositioning and fixation of the meniscus on the condylar stump, removal of articular eminence, excision of the retrodiscal tissue and normalising the position of the meniscus have been tried both in isolation and in combination with varying degrees of success. [16,17] All of these procedures, although effective in alleviating the symptoms, involve the surgical invasion of joint space which have their own complications like Infection, haemarthrosis and

fibrosis with resultant restriction in opening of mouth. Minimally Invasive Treatment for Internal Derangement of the Temporomandibular Joint termed Pterygoid Plate Disjunction was proposed in 2005. [18]

The rationale in pterygoid disjunction is when the pterygoid plates are fractured and separated from the maxilla and the sphenoid base; the pterygoid plates are pulled by the muscles to a comfortable position backwards and downwards. As a result, both the lateral pterygoid muscle and medial pterygoid muscle — especially the fibres attached to the pterygoid plates are relaxed. This reduces the spasm and strain on both pterygoid muscles and the protractile and upward force on the condyle and thereby increasing the joint space. Increase in the joint separation although marginal, will ease joint movements and reduce the stress on the bilaminar tissue. Disjunction and displacement of the pterygoid plates is minimally invasive and can be done as a day care procedure. Intermaxillary fixation with intensive physiotherapy is not required.



Figure 1: Michigan Type Splint



Figure 2: Michigan Type Splint



Figure 3: Sved Plate



Figure 4: Traditional Anterior Bite Plane



Figure 5: Soft Occlusal Splint



Figure 6: Dentinogenesis Imperfecta



Figure 7: Full Mouth Rehabilitation

Systematic Literature Review on Efficacy of Different Types of Occlusal Splints in the Conservative Management of TMJ Disorders:

There are mainly four types of splints commonly used in TMJ disorder management: Flat plane Stabilization appliance, Traditional Anterior Bite Plane appliance, Anterior Repositioning appliance and Posterior Bite Plane appliance

A detailed systematic literature review on efficacy of occlusal splints on TMDs was done. The studies showed varying outcomes, but most of them in favor of the efficacy of splints in TMDs

Shan Lung Lin in 2017 [19] conducted a study aimed to evaluate and compare the effectiveness of flat-plane splints (FPSs) with a vertical thickness of 3 mm (VT3) and 5 mm (VT5) in treating disc displacement without reduction (DDWOR).

The study concluded that both VT3 and VT5 FPSs can effectively improve various clinical symptoms of DDWOR and suggested the use of VT5 FPS for at least 1 year as a suitable treatment for DDWOR patients with joint crepitus sound and TMJ arthralgia. Littner et al in 2004 [20] conducted a study to evaluate the clinical-effectiveness of oral splints for patients with TMD or bruxism for the primary outcomes: pain (TMD) and tooth wear (bruxism).

From the various available data sources including MEDLINE and EMBASE, randomised controlled trials comparing all types of splints TMD were searched and study concluded that hard splints offer more successful outcomes than soft splints for TMDs. Seifeldin in 2015 [21] compared the efficacy of soft occlusal splint hard flat occlusal splint in TMD. He concluded that both forms of occlusal splints (soft and hard) improved TMJ symptoms in patients with MPD or ID of the TMJ. However after 4 months of usage, the superior results were achieved with soft occlusal splints. Amin A in 2016 [22] proved that hard, liquid, and soft splints produced statistically significant reduction in pain in myofascial pain dysfunction syndrome at the end of 3 months with hard splints giving superior relief compared to others.

Comparative evaluation of efficacy of muscle energy technique, occlusal splint therapy and combined treatment in the management of TMD was done by Ram HK in 2021 [23]. His study concluded that all the three treatment modalities provided significant relief in symptoms with combination method providing better result. Altaweel AA in 2021 [24] compared three effect of four approaches, centric splint, distraction splint, arthrocentesis and centric splint, arthrocentesis and distraction splint in the treatment of non-reductive TMJ disc displacement. Thirty-two patients (40 joints) were grouped in the study. Visual analog scale (VAS) was taken preoperatively, two weeks, one month, three, and six months postoperatively along with the presence of disc recapture and MRI.

The study revealed that all types of splints provide good result and combination of arthrocentesis along with occlusal splint produce more rapid and effective result. Yu CH et al in 2020 [25] conducted a study to retrospectively review and compare the effectiveness of four conservative treatments: counseling and occlusal splint therapy, counseling and manipulation integrated with electro physiotherapy, the combination of both and counseling alone. 168 patients who had limited jaw movement associated with myalgia were retrospectively observed in this study. Patients were divided into 4 groups: All patients were given counseling along with Group 1 Stabilization occlusal splint therapy, Group 2 Manipulation integrated with electro physiotherapy, Group 3 Combination of splint therapy, and manipulation integrated with electro physiotherapy, Group 4 Counseling alone. 12 weeks follow up were done for all subjects.

During clinical evaluation the intensity of pain and maximum mouth opening range without pain were recorded. Differences within the group and between the group were evaluated using analysis of variance (ANOVA) and the Kruskal-Wallis test.

The study result revealed that each of the included treatment modalities relieved spontaneous pain and tenderness to palpation of the masticatory muscles during the follow-up intervals. No much relief was

obtained with counseling alone. The best short term positive result was achieved by integrated treatment protocols including counseling, occlusal splint therapy, and manipulation and electro physiotherapy.

A network meta-analysis (NMA) of randomized controlled trials (RCTs) was performed by Al-Moraissi in 2020 [26] in which he assessed the effectiveness of various types of occlusal splint in the management of temporomandibular disorders (TMDs) and ranked them according to their effectiveness. Published RCTs were searched electronically. Predictor variables and possible outcomes of Forty-eight RCTs were tabulated.

For post-treatment pain reduction in arthrogenous TMDs, the three highest-ranked treatments were anterior repositioning splint (92%, very low quality evidence), counseling therapy along with hard stabilization splint (67.3%, low quality evidence), and hard stabilization splint alone (52.9%, moderate quality evidence). Based on this NMA of 48 RCTs multimodal therapy consisting of counseling therapy along with hard stabilization splint may produce the maximum improvement for TMD patients.

A study was conducted by Malgorzata Pihut et al in 2018 [27] to evaluate the efficacy of anterior repositioning splints in reducing pain related to temporomandibular joint disc displacement. 112 patients between the ages of 24 to 45 years, of both genders, were examined and diagnosed according to the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) protocol.

Total subjects were divided randomly into the study or control groups. In the lower arch a full anterior repositioning splint were used for around 20 hours for 4 months' time by the study group. A noninvasive therapy with biostimulation laser application were performed for control group every second day for over 12 sessions on the area of both temporomandibular joints with mouth open and mouth exercises time. Before treatment, 4 and 16 weeks postoperative pain intensity was evaluated using the Verbal Numerical Rating Scale (VNRS) and Mann-Whitney U test were used to analyze the data. The study concluded that the use of anterior repositioning splint effectively reduces pain associated with self-reducing disc displacement.

A study was conducted by Devi Jet al in 2017 [28] to diagnose temporomandibular disorder accurately, to do a subjective and objective evaluation of TMJ function, and to assess the effectiveness of different types of splint therapy over the conventional anterior repositioning appliance (ARA) group. Randomised clinical trial was done in 30 patients between the age of 18 and 55. Patients were assigned in three groups, i.e., conventional anterior repositioning appliance

group, centric stabilization splint and soft splint groups.

Subjects and Methods: Preoperative values of comfortable mouth opening and maximum mouth opening were measured in mm. Visual analog scale pain score (0–10 cm), TMJ clicking and tenderness (grading 0–3), and total energy values of both TMJs were recorded using JVA. The values at the time of insertion of splint and post-operative values at 1st, 2nd, 6th, and 10th week were recorded. The study concluded that the use of JVA for diagnosis along with history and clinical examination increased the accuracy of the diagnosis of DDR.

Although all the groups showed improvements statistically, the CSS group patients showed more significant improvement in the subsequent follow-up visits with consistent clinically effective responses. Nihat Akbulut in 2018 [29] conducted a study aimed at finding out whether the 3 mm thickness of stabilization splints has positive or negative effects on all temporomandibular disorder (TMD) symptoms. 25 TMD patients who received 3 mm thickness stabilization splint therapy were studied. The study showed 88 percent success rate with no remarkable effect of splints in TMDs in first 3 months' period. The mouth opening improved in 6 months and reached a remarkable success level in 12 months. The study concluded that use of 3 mm splint at least 12 hrs a day for a minimum of 6 months achieve remarkable results.

Zhang, C in 2016 [30] conducted a meta-analysis to evaluate the effectiveness of splint therapy for TMD in adults. An electronic search in Cochrane Library, PubMed, ClinicalTrials.gov and EMBASE were done for reports published. Thirteen eligible studies involving 538 patients were identified. The results indicated that splint therapy increased maximal mouth opening and reduced pain intensity measured using the visual analogue scale (VAS) for patients with TMD without specific description (TMDSD). Splint therapy also reduced the frequency of painful episodes for patients with TMJ clicking. On the basis of the evidence, they recommended the use of splints for the treatment and control of TMD in adults.

From the various available literature studies we can point down few observations:

1. Occlusal splint therapy is the most effective, cheapest and minimally invasive mode of treatment for the management of TMJ Disorders
2. Occlusal splint therapy provides significant relief in TMD symptoms with initial relief seen in first month of use itself and better results given with use of splint at least for 12 hours for 6 months.

3. Occlusal splint therapy should be maintained for a minimum of 3 months for allowing the healing of TMJ injury
4. The design or hardness of material used in fabrication of occlusal splint does not provide any significant difference.
5. A multimodal or combination therapy of arthrocentesis or muscle physiotherapy along with occlusal splints provides better result compared to a single mode of treatment

Conclusion

Extensive research is being conducted on the safety and effectiveness of TMD/orofacial pain treatments. Most researchers, dentists and physicians strongly recommend reversible and conservative treatments for TMD. Even when TMD symptoms are long lasting and severe, most TMD patients do not require invasive treatment. Treatments designed to permanently dental reconstruction by change of occlusion through full mouth rehabilitation or reposition of teeth or jaw by the way of orthodontics should be considered only if conservative measures fail to achieve its goal.

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