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Orthodontic Perspectives on Temporomandibular Joint Health and Disorders

Dr. Asmitha.Dayanand ,Dr. K.Nillan.Shetty
(Department Of Orthodontics And Dentofacial Orthopedics, A J Institute Of Dental Sciences, India)
(Department Of Orthodontics And Dentofacial Orthopedics, A J Institute Of Dental Sciences, India)

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Abstract
The temporomandibular joint (TMJ), a unique ginglymoarthrodial joint, is central to mastication, speech, esthetics, and oral function. Unlike other synovial joints, it is lined with fibrocartilage and contains a mobile disc that cushions mechanical stress while coordinating bilateral mandibular movement. Temporomandibular disorders (TMDs) are multifactorial in origin, influenced by biomechanical, genetic, psychological, and behavioral factors. Symptoms commonly include pain, restricted mandibular movement, and joint sounds. The role of occlusion and orthodontic treatment in TMD etiology remains controversial; however, orthodontic interventions may influence TMJ health by altering occlusal relationships and condylar positioning. Management emphasizes reversible modalities such as occlusal appliances, which aid in stabilizing joint position, reducing muscle activity, and facilitating adaptation of joint tissues. Definitive orthodontic treatment is considered only when orthopedic instability is proven to contribute to TMD. The orthodontist's primary goal is to achieve esthetic improvement in harmony with musculoskeletal stability of the TMJ, thereby ensuring long-term functional efficiency of the masticatory system.
Keywords: Temporomandibular joint, Temporomandibular disorders, Orthodontics, Occlusion, Splints

I. Introduction

The development of the temporomandibular joint (TMJ) begins around the tenth week of fetal growth. Classified as a ginglymoarthrodial joint, it plays a crucial role in essential functions such as chewing, speaking, facial aesthetics, and overall oral health [(1)] . This joint possesses several distinctive characteristics:

1. Unlike most joints, its articulating surfaces are lined with fibroelastic tissue instead of hyaline cartilage.
2. The cartilage in the condyle acts as a key growth site, contributing significantly to mandibular development.
3. It is unique in being the only joint that operates in a coordinated manner on both sides of the body.
4. The joint contains a disc that remains mobile during all movements, serving as a cushion to absorb mechanical stress.

The influence of dental occlusion on temporomandibular disorders (TMDs) has long been a topic of debate, sparking varied perspectives and ongoing controversy. [(2)] Research has explored both the structural changes in the TMJ resulting from orthodontic treatment and the potential negative effects associated with it. One major barrier to unified research has been inconsistent terminology. To address this, the American Dental Association standardized the nomenclature by introducing the term "temporomandibular disorders" (TM disorders). [(3)]

TMDs are typically characterized by symptoms such as jaw pain, restricted mouth opening, and clicking or popping sounds during joint movement.[(4)] According to the American Academy of Orofacial Pain, these disorders encompass a range of conditions affecting the jaw muscles, the TMJ itself, and related anatomical structures. [(5)]

II. Anatomy Of the Temporomandibular Joint

The temporomandibular joint (TMJ) is a specialized synovial joint of the condylar type, notable for its unique structural and functional characteristics. Its key anatomical components include the articular eminence, glenoid fossa, mandibular condyle, articular disc, discal ligaments, synovial membrane, joint capsule, and extracapsular ligaments.

The surface of the condyle is often referred to as fibrocartilage due to its composition. Shaped approximately like an elongated oval, the condyle measures around 15–20 mm from side to side (mediolateral) and 8–10 mm from front to back (anteroposterior). Nestled between the condyle and the temporal bone is the articular disc, which has a biconcave form and is divided into three distinct regions: the anterior band, intermediate zone, and posterior band. This disc is composed of fibrocartilage that lacks both blood vessels and nerve supply.

Synovial fluid within the joint is distributed across two compartments: the upper (superior) compartment holds about 1.2 ml, while the lower (inferior) compartment contains roughly 0.9 ml. This fluid is maintained under negative intra-articular pressure, which facilitates its spread across the joint surfaces as a thin capillary layer. This layer ensures smooth movement of the condyle by reducing friction. A key component of the synovial fluid is lubricin, a glycoprotein that plays a vital role in joint lubrication and minimizing wear between articulating surfaces. [6,7]

III. Etiology

Temporomandibular disorders (TMDs) have a **multifactorial etiology**, meaning they arise from a complex interplay of biological, psychological, and social factors

Biological & Mechanical Factors

- Muscle dysfunction: Overuse or imbalance in the masticatory muscles can lead to pain and dysfunction.
- Joint derangement: Internal issues like disc displacement or degenerative changes in the temporomandibular joint (TMJ).
- Trauma: Direct injury to the jaw or TMJ, including whiplash or prolonged mouth opening during dental procedures.
- Bruxism: Habitual teeth grinding or clenching, often during sleep.
- Malocclusion: Although once thought to be a major cause, recent research suggests bite issues play a limited role.

Genetic & Neurological Factors

- Pain sensitivity: Some individuals have heightened central pain processing, making them more susceptible to chronic TMD pain.
- Genetic predisposition: Certain genes may influence susceptibility to TMDs, especially those involved in pain modulation and inflammation.

Psychological & Behavioural Factors

- Stress and anxiety: These can lead to muscle tension, bruxism, and altered pain perception.
- Depression: Often coexists with chronic pain conditions like TMD.
- Sleep disturbances: Poor sleep quality can exacerbate pain and muscle tension.

IV. Disorder Treatment Plan

Orthodontic therapy is indicated only when orthopaedic instability is present and this instability is contributing to the TMD. The mere presence of orthopaedic instability is not enough evidence to be certain that it is contributing to the TMD, so clinician should first determine whether orthopaedic instability is contributing to TMD, the best way to identify this relationship is by first providing Orthopaedic stability reversibly with an Occlusal appliance. If the occlusal appliance does not reduce the symptoms orthopaedic stability is not related to the symptoms and orthodontics should not be considered. Orthodontic therapy can only affect TMD symptoms by changing the occlusal contact pattern of the teeth and the resulting function of the masticatory system. If an occlusal appliance successfully reduces the TMD symptoms Occlusion and Orthopaedic instability is an etiologic factor in the TMD.

Occlusal appliances reduce symptoms associated with TMD by

1. Alteration of the occlusal condition
2. Alteration of the condylar position
3. Increase the vertical dimension
4. Cognitive awareness
5. Placebo effect
6. Increase peripheral input to the central nervous system
7. Regression to the mean

To summarize permanent treatment is delayed until significant evidence exists to determine which factor or factors are in reducing the symptoms. Allow the patient to wear the appliance for several weeks or months to ensure that the symptoms have been controlled adequately. Discontinue use of the appliance and not experience the return of the symptoms indicates the muscle origin. These patients do not need orthodontic therapy. Splints-an occlusal appliance called a splint is a removable appliance usually made of hard acrylic that fits over the occlusal and incisal surfaces of the teeth in one arch creating precise occlusal contact with the teeth

of the opposing arch. It is commonly referred as bite guard, night guard, interocclusal appliance, orthopaedic device.

Types of Occlusal Appliances
• Stabilization splints
• Anterior stabilization splints
• Anterior bite plane
• Posterior bite plane
• Pivot splint
• Soft splint

The specific purpose of the splint should be determined before it is designed. Stabilization splint is a muscle relaxation appliance because it is primarily used to reduce muscle pain. It is generally fabricated on the maxillary arch and provides an optimum functional occlusion for the patient. The treatment goal of the stabilization splint is to eliminate any orthopaedic instability between the occlusal position and the joint position thus removing this instability as an etiologic factor in the TMD.[8,9,10]

Anterior repositioning splint is an interocclusal device that encourages the mandible to assume a position more anterior than the intercuspal position, its goal is to provide a better a condylar- disc relationship in the fossa so that tissues have a better opportunity to adapt to repair. The goal is not to alter the position of the mandible permanently but only to change the position temporarily as to enhance adaptation of retrodiscal tissues, once the tissue adaptation has occurred the appliance is eliminated allowing the condyle to assume the musculoskeletally stable position.[11]

Anterior bite plane is a hard acrylic appliance worn over the maxillary teeth, providing contact with only the mandibular anterior teeth. It is primarily intended to disengage the posterior teeth and thus eliminate their influence on the function of the masticatory system.

Posterior bite plane is fabricated for the mandibular arch and consists of areas of hard acrylic located over the posterior teeth and connected by a cast metal lingual bar. The treatment goal of the posterior bite plane is to achieve major alteration in vertical dimension and mandibular positioning.

Pivoting appliance is a hard acrylic device that covers one arch and usually provides a single contact in each quadrant which is usually established far posteriorly as possible. When superior force is applied under the chin the tendency is to push the anterior teeth close together and pivot the condyles downward around the posterior pivoting point. The appliance reduces interarticular pressure and thus unload the articular surfaces of the joint. whereas it was originally suggested that this therapy would be helpful in treating joint sounds, it now appears that anterior repositioning splint is more suitable for this purpose.

Soft or Resilient appliance is a device fabricated of resilient material that is usually adapted to the maxillary teeth the treatment goals are to achieve even and simultaneous contact with the opposing teeth.

According to classification by Slavicek there are myopathic splint, decompression splint, compression splint, verticalisation splint, anterior repositioning splint. The first four types are reference position splints, the last is a deranged reference position splint.

According to classification by Willis three major types of splints have been used traditionally they are Flat plane, anterior repositioning and canine protected splint works by prevention of lateral movements which reduces loading in the TMJ.

Reduction in para functional activity and immediate complete anterior guidance development which is effective in the treatment of MPDS.[12]

Rule of thirds by Neffan aid to determine the appropriate treatment.Each inner incline of the posterior centric cusps is divided into three equal parts if when the mandibular condyles are in their desired position the centric cusp tip of one arch contacts the opposing centric cusp inner incline in the third closest to the central fossa selective grinding done without damage to the teeth. If opposing centric cusp tip makes contact in the middle third of the opposing inner incline –crown and bridge prosthodontics procedures are appropriate for achieving the treatment goal, as selective grinding is likely to perforate the enamel. If the cusp tips contacts the opposing inner incline on the third closest to the cusp tip or even the cusp tip-orthodontic procedures are initiated as crown and fixed prosthodontics create restorations that cannot adequately direct occlusal forces through the long axis of the roots thus producing unstable occlusal relationship.[13]

V. Conclusion

• The goal of the orthodontist is to develop improved Dentofacial esthetics and a functional masticatory system. Although esthetics is often initially considered the most important goal, function eventually becomes far more important in the overall success of treatment.
• Therefore the clinician must always consider the ways in which orthodontic therapy affects function.

- To maximize sound orthopedic function, the occlusal condition must be finalized in harmony with the musculoskeletally stable position of the TMJs.
- Accomplishing this maximizes success of masticatory function in future years.

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