

Association Between Orthodontic Treatment And Temporomandibular Disorders: A Comprehensive Review

Urja Diyora

K. M. Shah Dental College And Hospital, Vadodara – 391760, India

Abstract:

The relationship between orthodontic treatment and temporomandibular disorders (TMD) has been a long-standing clinical debate. Occlusion-based theories of previously supported the notion that malocclusion and its orthodontic treatment may cause or prevent temporomandibular dysfunction but it has been realized today that TMD is multifactorial, to which biological, biomechanical and psychosocial factors are contributory. This narrative review critically reviews contemporary evidence pertaining to both the association between orthodontic therapy and TMD, as well as treatment outcomes associated with fixed appliances, extraction vs non-extraction protocols, functional appliances and orthognathic surgery. Most longitudinal studies and systematic reviews do not find significant causal relationships between orthodontic treatment and TMD. Extraction therapy and functional appliance therapy do not seem to display increased risks in the long term whilst a consensus seems that adaptive or non-pathological joint changes occur in growing individuals. It seems that these orthodontic intervention, cementum-driven features are better predictive of later dysfunction than anything else we have, not to mention premorbid joint conditions and individual susceptibility factors. According to available evidence, malocclusion and orthodontic treatment should not be viewed as the main etiopathogenic factor of TMD; however, meticulous pretreatment assessment and posttreatment monitoring are crucial in evidence-based clinical practice.

Keywords: Temporomandibular disorders (TMD); Orthodontic treatment; Temporomandibular joint (TMJ); Malocclusion; Functional appliances.

Date of Submission: 23-03-2026

Date of Acceptance: 03-04-2026

I. Introduction

The temporomandibular joint (TMJ) is the most complex type of synovial joint in the human body, formed between the mandibular condyle and the fossa glenoid of the temporal bone. It is a bilaterally loosened articulation working concomitantly with masticatory muscles and occlusal system to enable mastication, phonation and mandible shifting. It is a complex joint with an articular disc, fibrous capsule, ligaments and associated musculature that permits both rotational and translational movements [1].

Diseases of this joint and its associated musculature are collectively referred to as temporomandibular disorders (TMD). TMD is a heterogeneous group of disorders of the masticatory musculature, temporomandibular joint or both. Epidemiological evidence shows that aspects of TMD can be found in a large part of the population, but only a smaller portion reports clinically relevant symptoms. The disorder is more common in females and young to middle-aged adults, which indicates possible hormonal and psychosocial effects.

TMD in general can be divided into three main groups: muscular, articular and degenerative based upon unique clinical signs and symptoms such as pain, joint noises, restriction of mandibular movement or episodes of locking.

Table 1: Classification of Temporomandibular Disorders [2, 3]

Category	Description	Common Clinical Features
Myofascial Pain	Muscular origin involving masticatory muscles	Tenderness, fatigue, limited mouth opening
Disc Displacement	Internal derangement of articular disc	Clicking, locking, deviation on opening
Arthralgia	Inflammatory joint pain	Pain on function, joint tenderness
Osteoarthritis	Degenerative joint changes	Crepitus, stiffness, radiographic alterations
Hypermobility	Excessive joint translation	Subluxation, jaw instability

Currently, the aetiology of TMD is considered multifactorial. Modern models incorporate a biopsychosocial perspective, including biomechanical, neuromuscular, psychological and endocrine and genetic factors. Traditionally, however, occlusion was perceived as the chief etiological factor. It was thought that malocclusion created abnormal functional loading of the TMJ, thus starting or maintaining a dysfunction.

Orthodontic therapy, aimed at the correction of malocclusion and the improvement of dentofacial harmony, has, therefore, been linked to TMD pathogenesis and treatment. Approximately the first- and second-

generation occlusal theories proposed that orthodontic therapy could prevent or mitigate temporomandibular disorders by achieving a stable and balanced occlusion. On the other hand, there are concerns that orthodontic therapy (especially regarding extractions and long-distance tooth movements may change mandibular position and could lead to TMJ dysfunction [4].

In the last three decades, further focus on standardised TMD diagnostic criteria has led to refinement of these tools; specifically, the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) and their own updated version, the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD). These have also helped to move the paradigm away from one focusing solely on occlusion as a cause, rather towards one that recognizes the multifactorial biopsychosocial nature of oral disease. However, the association between orthodontic treatment and TMD continues to be controversial, with contrasting results reported from epidemiological, longitudinal, and interventional-type studies [5].

A focused review on the current literature is warranted due to the clinical implications of adequate risk and best treatment planning, informed consent, medicolegal and evidence based guidelines.

Thus, the aim of this review is to critically appraise and synthesize the existing literature on the relationship between orthodontic treatment and temporomandibular disorders (TMD), with the purpose of establishing whether orthodontic therapy acts as a risk factor, protective factor or has no effect at all on TMD development.

II. Anatomy Of The Temporomandibular Joint

The temporomandibular joint is a bilateral synovial articulation between the mandibular condyle and the mandibular (glenoid) fossa of the temporal bone. The TMJ differs from most synovial joints in that it has an articular disc made of dense fibrocartilaginous tissue, separating the joint into a superior and inferior compartment. This special architecture allows complicated motions of the mandible involving both rotation and translation.

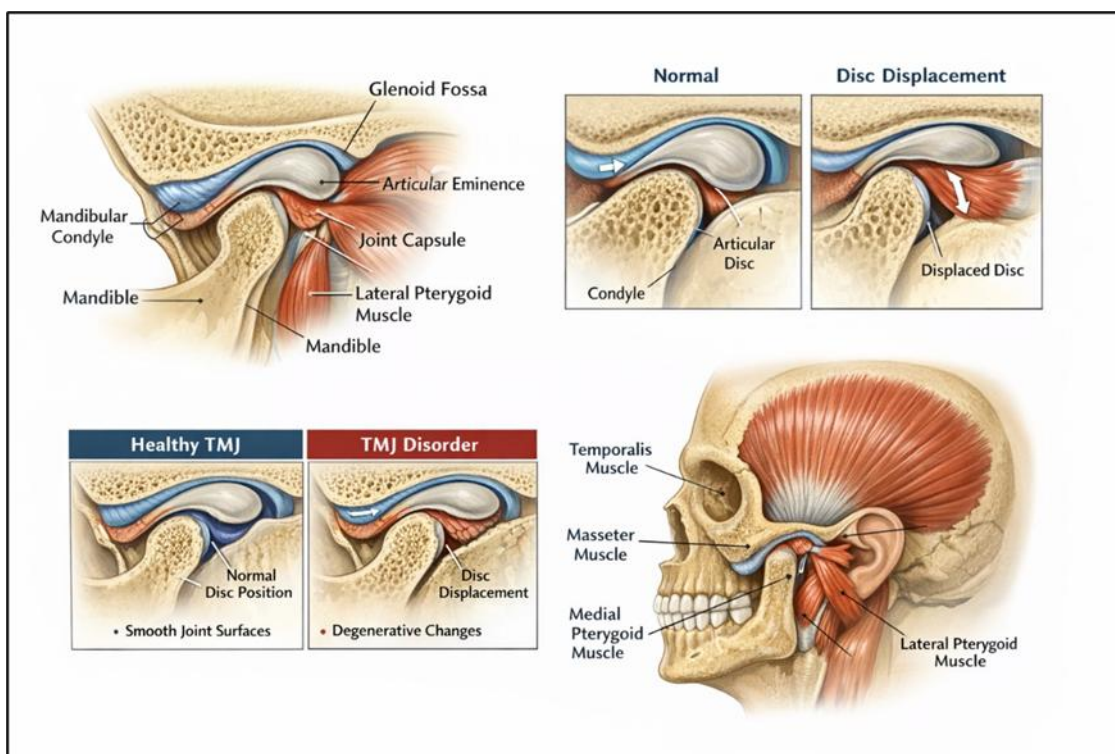


Figure 1: Anatomy of the TMJ showing the mandibular condyle, articular disc, glenoid fossa, joint capsule and ligaments [6]

The special structure of the articular disc helps to distribute loads and stabilise the joint. The anatomical configuration of the TMJ is a very complex joint that responds to functional stresses and also provides smooth articulation with mandibular movement. Mechanical stability is further ensured by the joint capsule, collateral ligaments and temporomandibular ligament, whereas movement and force transmission are influenced by the muscles of mastication (masseter, temporalis, medial and lateral pterygoids).

Functional Biomechanics

The joints of the TMJ have two joint movements:

1. Rotation (hinging movement) – takes place in the inferior joint compartment on mouth opening.
2. Translation (sliding) – occurs in the superior joint compartment as the condyle-disc complex translates anteriorly on the articular eminence.

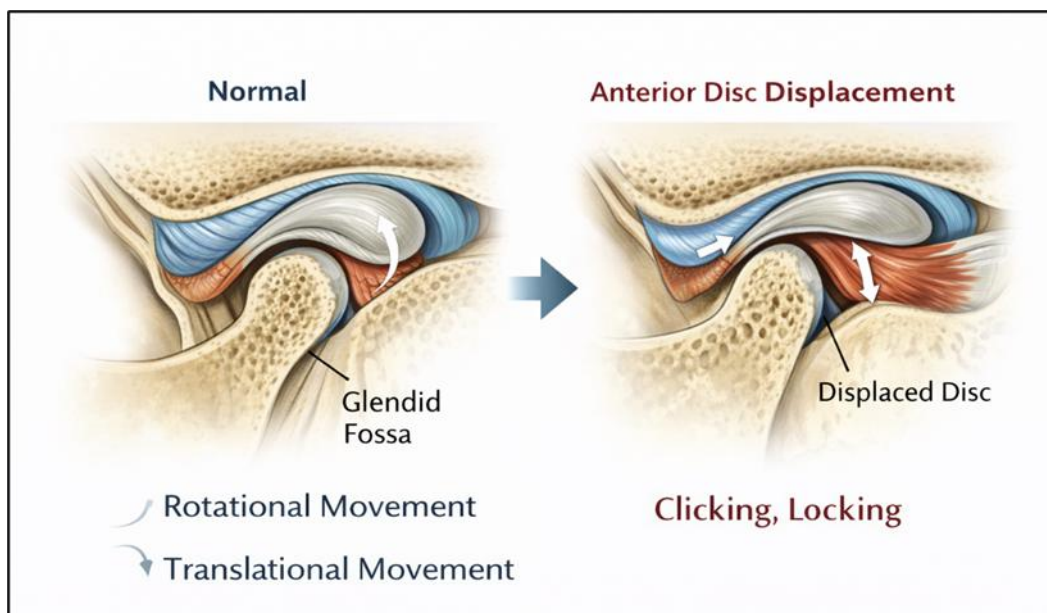


Figure 2: Normal TMJ rotational and translational motions and comparison with the anterior disc displacement

Normal joint function entails the structured movement of the condyle with the articular disc. This coordination may be disrupted by such conditions as anterior disc displacement, resulting in clicking sounds, locking or pain—signature features of TMD [7].

Biomechanical Load and Occlusion

TMJ functional loading is controlled by:

- Occlusal relationships
- Parafunctional habits (e.g., bruxism)
- Muscle activity
- Psychological stress
- Skeletal pattern

While occlusion used to be perceived as a determinative factor in TMJ loading, recent evidence has illustrated that much of the health of the joint is dependent upon its adaptive capacity and neuromuscular control. The TMJ has a unique power of remodelling according to mechanical loading, which is more significant in growth and orthodontic treatment [8].

III. Temporomandibular Disorders: Etiology And Pathophysiology

Temporomandibular disorders (TMD) are a heterogeneous group of conditions that involve musculoskeletal and neuromuscular dysfunctions, including those that affect the temporomandibular joint (TMJ), masticatory muscles, and related structures. Previous conceptual models have focused on occlusal discrepancies as the primary contributory etiological mechanism. Nevertheless, recent studies have shown that TMD is a multifactorial entity characterised by an interplay of biological, mechanical, psychological and environmental factors. This paradigm shift needs to be taken into consideration when assessing any possible association between orthodontic treatment and TMD [9].

As described before, current pieces of evidence support a biopsychosocial model whereby predisposing, initiating and perpetuating factors interact through synergistic pathways to foster disease onset and progression. Predisposing factors may include genetic susceptibility, hormonal influences—especially the higher incidence seen in females—connective tissue laxity and certain skeletal patterns. The initiating events are often macrotrauma (mandibular trauma) or microtrauma due to parafunctional habits (bruxism and clenching). Perpetuating variables like psychological stressors, anxiety, depression and central sensitisation possibly worsen perceiving pain and lead to chronicity.

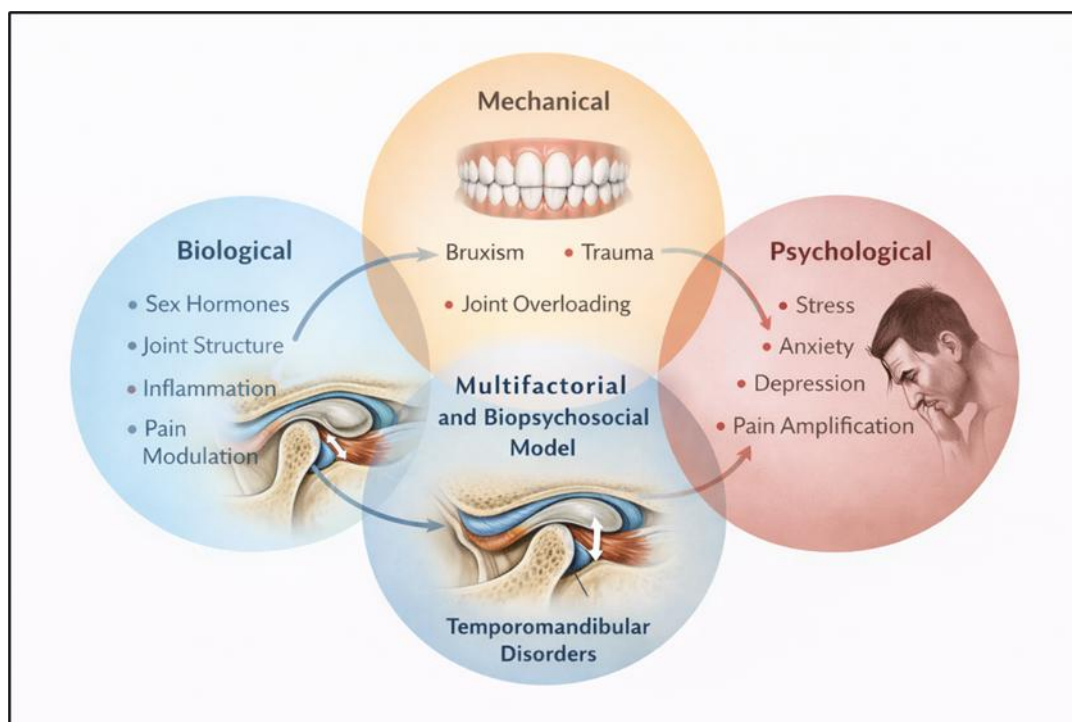


Figure 3: Biopsychosocial and multifactorial model indicates how biological, mechanical, and psychological contributors interact in temporomandibular disorders.

The pathophysiologic process of TMD is different between the primarily muscular and intra-articular types. Muscular TMD, also described as myofascial pain, is defined by heightened muscle tone and the development of trigger points and localized ischemia with changes in neuromuscular control. The active muscle(s) that has been over-stimulated for a prolonged period may become sensitised and, in chronic conditions, potentially the central nervous system's perception of pain can be sensed from trivial afferent input producing dramatic responses without significant change in structural pathology [10, 11].

On the other hand, intra-articular TMD consists of structural changes in the joint. Disc displacement with (clicking) and without reduction (limited opening and locking) is the most common presentation. Mechanical stress on the joint can induce pro-inflammatory reactions within the synovial membrane and lead to synovitis or capsulitis. Over time, chronic loading or inflammatory activity can trigger degenerative remodeling of the condyle and articular surfaces, leading to osteoarthritic changes. Despite these potential pathological mechanisms, the temporomandibular joint has significant adaptive and remodeling abilities according to the growth phases as well as orthodontic treatment interventions.

To all historians, malocclusion was a major cause of joint derangements. Longitudinal and epidemiological studies have shown that occlusal factors explain a limited proportion of the variance in TMD. They can be asymptomatic despite severe malocclusion, while highly ideal occlusion may progress to TMD. This evidence supports the idea of occlusion manifesting more as a modifying (or contributing) factor instead of being a primary agent within the aetiology. Hence, the notion that malocclusion can be corrected by orthodontics and leads to TMD or as orthodontics as a causative factor for TMD has to be critically analyzed in light of evidence-based guidelines [11].

Before we address potential implications to joint health from orthodontic treatment, it is fundamental to understand the multifactorial aetiology and complex pathophysiology of TMD. In the following section, we will review orthodontic treatment modalities and the potential mechanisms contributing to their effects on temporomandibular structures.

IV. Orthodontic Treatment Modalities And Their Potential Effects On Temporomandibular Disorders

Orthodontic treatment focuses on malocclusion correction, dentofacial aesthetics improvement and functional occlusal relationships establishment. Due to the fact that orthodontic therapy is directly related to changing occlusion, and subsequently may alter the position of the mandible, it has long been suggested as both a preventative modality and possible etiologic factor for temporomandibular disorders (TMD). Therefore, when assessing a potential link between different orthodontic modalities and TMD, the biological and biomechanical effects are essential.

Orthodontic appliances apply controlled forces to cause tooth mobility by the remodelling of the periodontal ligament and adaptation of alveolar bone. Although these forces primarily act on dentoalveolar structures, they have been argued to indirectly affect temporomandibular joint (TMJ) loading and condylar positioning. Might alter lower jaw position, bite and chewing motion and adaptations of joint muscles within the effects on their functioning [12].

Fixed Appliances and Clear Aligners

Traditional fixed appliances (brackets) and clear aligner systems are the most commonly used active orthodontic methods. They gradually modify occlusal relations and dental axial positioning. While occlusal changes can lead to an alteration in mandibular intercuspation, the current evidence still demonstrates that the stomatognathic system may adapt to these modifications. During active tooth movement, transient discomfort or muscle soreness can occur; however, such symptoms are usually self-limiting and not representative of chronic TMD.



Figure 4: Common orthodontic treatment modalities [13]

Importantly, consistent cohort high-quality evidence as well does not show that fixed orthodontic treatment leads to an increased long-term risk of TMD. The majority of reported symptoms during treatment are mild and reversible.

Extraction and Non-Extraction Therapy

As per previous work premolar extraction therapy has been among the most controversial questions about orthodontics in relation to TMD. The anterior teeth were retracted and the mandible could posteriorly position, which would change condylar position in the glenoid fossa and therefore, increase stress into joints. Nevertheless, cephalometric and imaging analyses have not always shown clinically significant posterior condylar displacement (with respect to extraction therapy alone) [14].

During the long-term follow-up period, most observational studies report that there are no significant differences in TMD prevalence between patients who were treated with extraction and those treated without extractions. In most individuals, the TMJ and neuromuscular system seem to have an adaptive capacity such that occlusal and positional changes are compensated.

Functional Appliances and Mandibular Advancement

Functional appliances have been utilized to change the skeletal discrepancies during growth, especially in Class II malocclusions. These appliances position the mandible anteriorly, which may change condyle-disc relationships and joint loads. Adaptive remodelling of the condyle and glenoid fossa may also occur during treatment, especially in growing patients.

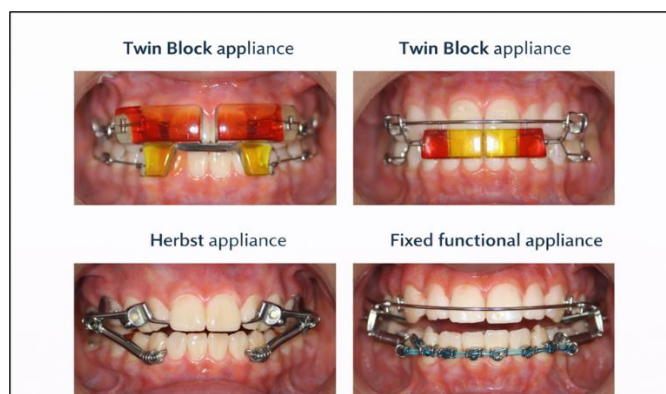


Figure 5: Functional appliances [15]

Although some alteration of the joint position occurs during retention, not only is this expected by definition but existing literature supports the notion that it functions more adaptively than pathologically. The evidence is insufficient to prove that functional appliances are responsible for actual long-term TMD in otherwise healthy individuals.

Orthognathic Surgery

Orthognathic surgery is a more invasive modality involving the surgical repositioning of the jaws. Since it directly modifies bony relationships and condylar positioning, it can affect TMJ biomechanics more beneficially than traditional orthodontics. Orthognathic surgery has, in some studies, also been seen to decrease pre-existing TMD symptoms, particularly in patients with severe skeletal discrepancies. A subset of patients experience postoperative joint symptoms related to the surgical technique, fixation stability, and / or preoperative joint status.

V. The Temporal Relationship Between Orthodontic Treatment And The Onset Of Temporomandibular Disorders.

TMD and orthodontic treatment have been the focus of research over the last several decades. Initial hypotheses proposed a causal relationship between occlusal discrepancies and TMD, but modern studies have generated predominantly conflicting and sometimes contradictory data. This short critical literature appraisal reveals that most longitudinal and systematic high-quality investigations do not support a strong causal relationship between orthodontic therapy and TMD.

Observational and Longitudinal Studies

Early retrospective studies indicated a potential link between orthodontic treatment and TMJ symptoms, especially in extraction candidates. There were, however, limitations of these investigations such as small sample size, lack of standardized diagnostic criteria, control groups and short duration follow-ups.

More recent longitudinal cohort studies, grounded in standardized diagnostic systems such as the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) and Diagnostic Criteria for TMD (DC/TMD), have shown that orthodontic treatment does not contribute substantially to long-term risk of TMD. For many outcomes, the prevalence of TMD symptoms among treated individuals was similar to that in untreated controls. Moreover, all incidental transitory joint sounds or mild discomfort were self-limiting during active treatment without persistent dysfunction [16].

These results indicate esoteric that orthodontic treatment can not be an independent hazardous elements but merely a temporal event in patients with the initial susceptibility to TMD.

Evidence review on Extraction vs Non-Extraction Therapy

One of the most controversial issues revolves around whether premolar extraction therapy predisposes patients to TMD via posterior mandibular repositioning. Multiple cephalometric and imaging-based studies have attempted to preserve condylar position after extraction protocols. Even when minor positional changes were observed, such variations remained within the physiological range and could not be consistently correlated with clinical signs of TMD [17].

At long-term follow-up, comparison studies between extraction and non-extraction groups have shown mainly no differences in TMD prevalence or severity. The adaptive remodelling potential of the temporomandibular joint seems to offset occlusal and dentoalveolar alterations brought on by orthodontic mechanics.

Functional Appliances and TMD Risk

Functional appliances, especially one that advances the mandible, induce transient changes in both condylar position and joint loading patterns. Although short-term imaging studies have demonstrated adaptive remodeling during growth, there is also insufficient evidence to suggest that appliances should be avoided in otherwise healthy individuals because of a potentially increased long-term risk of TMD. In developing patients, orthopedic adaptability may indeed be greatest in favor of enhancing overall joint harmony with patient selection.

However, this suggestion should be interpreted with caution in patients already experiencing TMD symptoms prior to therapy. The baseline status of the joints seems to be more relevant for predicting future dysfunction than the orthodontic intervention [18].

Systematic Reviews and Meta-Analyses

Overall, high-evidence data encompassing systematic reviews and meta-analyses found no meaningful evidence of orthodontic treatment having anything but a negligible effect on the promotion or reduction of TMD. Most of the analyses focus on heterogeneity in diagnostic criteria and study design, or confounding variables, which include age, sex, parafunctional habits and psychological factors.

Most reviews of the literature published to date support the contention that orthodontic therapy should not be considered a primary etiologic factor in temporomandibular joint dysfunction (TMD). Orthodontic treatment does not seem to be the causative factor; rather, TMD seems to develop as a result of multifactorial interactions, regardless of orthodontic intervention in most cases [19].

Summary of Current Evidence

To review the existing literature, the overall evidence indicates:

- A no persisting causal link between TMD and orthodontic treatment.
- Extraction therapy does not increase long-term risk for TMD.
- Growing patients demonstrate adaptive, not pathologic joint changes with the use of functional appliances.
- Orthodontic treatment in itself is not as strong a predictor of future symptoms compared to pre-existing TMD.

Table 2: Summary of Evidence Regarding Orthodontic Treatment and TMD [20, 21]

Research Category	Overall Findings	Strength of Evidence
Longitudinal Cohort Studies	No significant increase in TMD after orthodontics	Moderate to High
Extraction vs Non-Extraction	No consistent difference in TMD prevalence	Moderate
Functional Appliances	Adaptive changes; limited evidence of harm	Moderate
Systematic Reviews	No strong causal association established	High

VI. Clinical Implications And Risk Assessment

There is no sufficient evidence currently supporting a strong causal relationship between orthodontic treatment and the development of TMD, but this topic remains clinically relevant. As orthodontists often see patients with pre-existing TMJ symptoms or concerns about developing joint pain, they play an important role in making sure these problems do not occur during treatment. An evidence-based risk assessment and monitoring protocol is critical to safe clinical practice.

Screening and baseline assessments prior to treatment

As the first part of a full pre-treatment assessment, TMJ function and symptoms should also be assessed. It includes an assessment of joint sounds (clicking, crepitus), pain on palpation, range of motion of the mandible, opening deviation, locking episodes history and parafunctional habit as bruxism. It is crucial to establish a baseline with respect to the status of the joint, as pre-existing TMD has been shown to be a stronger predictor of future symptoms than orthodontic treatment [20].

Before commencing orthodontic treatment, conservative management should be implemented in patients with active TMD, including physiotherapy, occlusal splints, behavioural modification and pain control. Orthodontic treatment is elective and can usually be postponed until acute symptoms are controlled [21].

Communication with Patients and Informed Consent

With continuing public scrutiny concerning orthodontics and TMJ dysfunction, open communication is key. Patients should be told that current scientific evidence does not indicate a conclusive cause-effect relationship between orthodontic treatment and TMD. However, they must also be made aware that some temporary discomfort and/ or muscle soreness associated with active tooth movement is expected.

Diligent documentation of baseline findings and discussion of systems that may affect clinical outcomes minimizes potential medico-legal vulnerability while also maximizing patient trust. Fundamentally, informed consent requires evidence-based knowledge free of outdated occlusal concepts [22].

Monitoring During Treatment

TMJ status should be periodically evaluated, as part of routine follow up during orthodontic therapy. Any new onset of chronic joint pain, limited opening, or functional impairment should be evaluated expeditiously.

Mild symptoms most commonly occurring during treatment are self-limiting and likely be associated with a temporary period of occlusal instability or muscle adaptation. Conservative measures— of occlusal adjustment (if indicated), short-term appliance modification, physiotherapy referral or behavioral therapy are sufficient most of the time. Discontinuation of orthodontic therapy is seldom indicated except in the event of significant pathology being diagnosed [23].

Patients with pre-existing TMD

An exception may be cases of temporomandibular disorder (TMD), where orthodontic treatment is not contraindicated in the presence of TMD history as long as symptoms are stable and diligently managed. All available evidence indicates that orthodontic therapy does not reliably cure or uniformly exacerbate TMD. In specific instances, combined orthodontic-orthognathic treatments used to correct severe skeletal discrepancies may actually improve joint function.

Complex cases require a multidisciplinary approach with orthodontists, oral medicine specialists, physiotherapists and pain management experts.

Medico-Legal Considerations

Medico-legal dispute over whether orthodontic treatment causes TMD stems from a historical belief. Nevertheless, recent systematic reviews consistently show that the evidence for a causal link is inadequate. Good documentation of TMJ status, treatment goals, and informed consent go a long way toward reducing legal risk.

Clinicians should not guarantee prevention or cure of TMD through orthodontic correction alone without robust evidence from the literature to support such claims [24].

VII. Conclusion

For decades, orthodontic treatment and its impact/relation with temporomandibular disorders (TMD) becomes a matter of scientific and clinical works. Previous theories prioritized occlusal anomalies as key etiological agents; however, current literature supports a multifactorial and biopsychosocial framework for understanding the pathogenesis of TMD. Under this updating concept, orthodontic therapy does not seem to act as a likely primary factor in the initiation of temporomandibular disorders.

Longitudinal studies, comparative analyses, and systematic reviews mostly show that orthodontic treatment such as fixed appliances, extraction therapies or functional orthopaedic interventions do not significantly increase the risk of long-term TMD in the population. Symptoms during treatment are short-lived and self-resolving in 80% of cases. In addition, joint pathology and individual susceptibility factors present as better predictors for future dysfunction than orthodontic mechanisms alone.

While it cannot be said that orthodontic intervention represents a preventive or treatment modality for TMD in the majority of circumstances, nor should it be demonised as being unconditionally injurious to joint tissue when care is prescribed and followed carefully. Thorough pre-treatment screening, proper documentation and continued clinical evaluation are still integral aspects of responsible Orthodontic practice.

Prospective longitudinal studies of high methodological quality applying standardized diagnostic criteria and advanced imaging modalities, and with follow-up into the long term, are required to further elucidate subtle biomechanical adaptations of the temporomandibular joint during and following orthodontic intervention. By continuing to inform clinical decision making, such data will serve to further enhance the evidence based foundation upon which contemporary orthodontic practice rests.

Reference

- [1]. The Role Of Occlusal Factor In The Etiology Of Temporomandibular Dysfunction. Dodić S, Sinobad V, Obradović-Djurčić K, Medić V. *Srp Arh Celok Lek.* 2009;137:613–618. Doi: 10.2298/Sarh0912613d.
- [2]. Prevalence Of Malocclusion, Oral Parafunctions And Temporomandibular Disorder-Pain In Italian Schoolchildren: An Epidemiological Study. Perrotta S, Bucci R, Simeon V, Martina S, Michelotti A, Valletta R. *J Oral Rehabil.* 2019;46:611–616. Doi: 10.1111/Joor.12794.
- [3]. Prevalence Of Temporomandibular Disorders And Oral Parafunctions In Adolescents From Public Schools In Southern Italy. Paduano S, Bucci R, Rongo R, Silva R, Michelotti A. *Cranio.* 2020;38:370–375. Doi: 10.1080/08869634.2018.1556893.
- [4]. Experimental Methods To Inform Diagnostic Approaches For Painful TMJ Osteoarthritis. Sperry MM, Kartha S, Winkelstein BA, Granquist EJ. *J Dent Res.* 2019;98:388–397. Doi: 10.1177/0022034519828731.
- [5]. Pain Of Temporomandibular Disorders: From Etiology To Management. Wieckiewicz M, Shiau YY, Boening K. *Pain Res Manag.* 2018;2018:4517042. Doi: 10.1155/2018/4517042.
- [6]. Malocclusion As A Cause For Temporomandibular Disorders And Orthodontics As A Treatment. Shroff B. *Oral Maxillofac Surg Clin North Am.* 2018;30:299–302. Doi: 10.1016/J.Coms.2018.04.006.
- [7]. D L, Klasser G. *Orofacial Pain: Guidelines For Assessment, Diagnosis, And Management.* 4th Ed. Quintessence; 2013 Pain Aaoo, Ed.
- [8]. Benoliel R, Zini A, Zakuto A, Et Al. Subjective Sleep Quality In Temporomandibular Disorder Patients And Association With Disease Characteristics And Oral Health-Related Quality Of Life. *J Oral Facial Pain Headache.* 2017; 31(4): 313-322. Doi:10.11607/Ofph.1824
- [9]. Almozino G, Zini A, Zakuto A, Et Al. Oral Health-Related Quality Of Life In Patients With Temporomandibular Disorders. *J Oral Facial Pain Headache.* 2015; 29(3): 231-241. Doi:10.11607/Ofph.1413
- [10]. Christidis N, Lindstrom Ndanshau E, Sandberg A, Tsilingaridis G. Prevalence And Treatment Strategies Regarding Temporomandibular Disorders In Children And Adolescents-A Systematic Review. *J Oral Rehabil.* 2019; 46(3): 291-301. Doi:10.1111/Joor.12759
- [11]. Valesan LF, Da-Cas CD, Reus JC, Et Al. Prevalence Of Temporomandibular Joint Disorders: A Systematic Review And Meta-Analysis. *Clin Oral Investig.* 2021; 25(2): 441-453. Doi:10.1007/S00784-020-03710-W
- [12]. Slade GD, Ohrbach R, Greenspan JD, Et Al. Painful Temporomandibular Disorder: Decade Of Discovery From OPPERA Studies. *J Dent Res.* 2016; 95(10): 1084-1092. Doi:10.1177/0022034516653743
- [13]. Jeon DM, Jung WS, Mah SJ, Kim TW, Ahn SJ. The Effects Of TMJ Symptoms On Skeletal Morphology In Orthodontic Patients With TMJ Disc Displacement. *Acta Odontologica Scandinavica.* 2014; 72: 776–782.
- [14]. Bi R, Li Q, Li H, Wang P, Fang H, Yang X, Et Al. Divergent Chondro/Osteogenic Transduction Laws Of Fibrocartilage Stem Cell Drive Temporomandibular Joint Osteoarthritis In Growing Mice. *International Journal Of Oral Science.* 2023; 15: 36.
- [15]. Wang Q. *Correlation Between Temporomandibular Joint Disc Displacement And Craniomaxillofacial Morphology In Adults* [Master's Thesis]. China Medical University. 2019.

- [16]. Zhu H, Song X, He D, Yang Z, Shan Y. Research Progress In The Relationship Between Temporomandibular Joint Anterior Disc Displacement And Dentofacial Deformities In Juveniles. *Chinese Journal Of Practical Stomatology*. 2017; 10: 754–759.
- [17]. Wan S, Li P, Xie Q, Chen J, Qian Z, Yang C. Characteristics Of Mandible Deviation In Adolescent Patients With Temporomandibular Joint Anterior Disc Displacement. *Journal Of Shanghai Jiao Tong University*. 2022; 42: 1557–1561.
- [18]. Liu Z, Xie Q, Yang C, Chen M, Bai G, Abdelrehem A. The Effect Of Arthroscopic Disc Repositioning On Facial Growth In Juvenile Patients With Unilateral Anterior Disc Displacement. *Journal Of Cranio-Maxillo-Facial Surgery*. 2020; 48: 765–771.
- [19]. Jiménez-Silva A, Carnevali-Arellano R, Venegas-Aguilera M, Tobar-Reyes J, Palomino-Montenegro H. Temporomandibular Disorders In Growing Patients After Treatment Of Class II And III Malocclusion With Orthopaedic Appliances: A Systematic Review. *Acta Odontologica Scandinavica*. 2018; 76: 262–273.
- [20]. Katzberg RW, Westesson PL, Tallents RH, Drake CM. Orthodontics And Temporomandibular Joint Internal Derangement. *American Journal Of Orthodontics And Dentofacial Orthopedics*. 1996; 109: 515–520.
- [21]. Lei J, Yap AU, Liu MQ, Fu KY. Condylar Repair And Regeneration In Adolescents/Young Adults With Early-Stage Degenerative Temporomandibular Joint Disease: A Randomised Controlled Study. *Journal Of Oral Rehabilitation*. 2019; 46: 704–714.
- [22]. Shen P, Bai G, Xie Q, Fang Y, Pan L, Geng Y, Et Al. Efficacy Of Arthroscopic Discopexy On Condylar Growth In Temporomandibular Joint Anterior Disc Displacement: A Randomized Clinical Trial. *Plastic And Reconstructive Surgery*. 2023; 154: 544e–555e.
- [23]. Ma Z, Yang C, Xie Q, Shen Y, Shen P, Fang B, Et Al. MRI Evaluation Of Functional Treatment In Juvenile Disk Displacement With Reduction. *China Journal Of Oral And Maxillofacial Surgery*. 2013; 11: 131–135.
- [24]. Hu X, Zhu Y, He L, Gu Y, Liang Z, Zheng C. Skeletal Effects Of Modified Twin-Block On Patients In Non-Growth Period With Disc Displacement With Reduction. *Journal Of Oral Science Research*. 2017; 33: 550–553.