ISSN: 0975-766X
CODEN: IJPTFI
Available Online through ***Review Article***
www.ijptonline.com

ADVERSE EFFECTS OF MYOFUNCTIONAL AND FIXED APPLIANCE ON THE TEMPOROMANDIBULAR JOINT - A REVIEW

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Received on 20-10-2019 *Accepted on: 02-12-2019*

Abstract:

Aim: To better understand the adverse effects of orthodontic treatment on the temporomandibular joint.

Background: Temporomandibular joint disorders are considered multifactorial etiology conditions involving trauma, anatomical, pathophysiological, and psychosocial factors. The relationship between orthodontic treatment, abnormal condyle and disc position, and temporomandibular disorders (TMD) has been investigated for many years.

Conclusion: Even though some evidence has been presented against orthodontics the relationship between orthodontic treatment and TMD is still unclear. More research is required in this field to improve our understanding and enable better treatment.

Key words: orthodontics, orthodontic treatment, myofunctional treatment, Temporomandibular disorder

Introduction

Orthodontics comes from the Greek words “orthos”, meaning correct/straight & (dontos), meaning teeth. It is that specialised branch of dentistry concerning with the management of deviations from the normal position of the teeth, jaws and face (malocclusions). Orthodontic treatment can improve both the function and appearance of the mouth and face.[1] The main aims of orthodontic care are to correct malocclusion which is not a disease but simply a marked variation from what is considered to be the normal position of teeth, produce a healthy, functional bite, creating greater resistance to disease and improving personal appearance[2,3] contributing to the mental, as well as the physical, well-being of the individual.

Introduction

Aesthetic awareness combined with the development of new aesthetic orthodontic techniques has increased the number of patients seeking orthodontic treatment. Because orthodontic treatment lasts around 2 years, anxiety soars high in patients who have apprehension regarding teeth/jaw alignment correction techniques due mostly to the Myth or fact linking the cause and effect relationship between orthodontic treatment and Temporomandibular Joint and Disorders and patients may complain about TMD during or after treatment and orthodontists may be blamed for causing TMD by unsatisfied patients. This hypothesis of causality has led to legal problems for dentists and orthodontists. For these reasons, the interest in the relationship between occlusal factors, orthodontic treatment and TMD has grown and many studies have been conducted.[4] Multiple scientific studies and clinical researches discerning and investigating the possible relationship between orthodontic therapy and TMDs appear from the mid of the last century, with the first reference to correlate the occlusion with the symptoms of the TMJ carried out by Costen in 1934. [4]

Anatomy of Temporomandibular Joint

TMJ or Temporomandibular joint is the joint that connects the jaw bone (mandible) to the temporal bone of the skull; one on either side of the face just below the ear; permitting free movement of the jaw bone. This bilateral joint functions to open and close the jaws and to approximate the teeth of the opposing arches during mastication. The articulation is made up of the mandibular condyle and the squamous portion of the temporal bone. Interposed between the two bones is a fibrous articular disc, compartmentalizing the joint into two separate synovial-lined cavities separating the condyle and the fossa. It acts as a shock absorber. The hinge joint is covered by dense, fibrous connective tissue surrounded by several joint ligaments. Several pairs of muscles are attached to the mandible producing the movements necessary to suckle, ingest, and masticate food; swallow; yawn; and produce speech. Functional stability of the neuromuscular and stomatognathic system while in occlusion and accurate temporomandibular articulation are of pivotal importance as treatment of these influences the functioning of the complete system. The condyle is made of compact bone, covered by a layer of fibrocartilage which in turn, is covered by a thin layer of proliferative tissue which becomes activated while remodelling of the joint as a result of changes in function, wear and tear, and orthodontic/normal tooth movement.[5]

Orthodontics and Dentofacial Orthopedics is the specialty area of dentistry concerned with the supervision, guidance and correction of the growing or mature dentofacial structures, including those conditions that require movement of teeth, correction of malalignment /maldevelopment of the stomatognathic system and proper arrangement of relationships between and among teeth and facial bones by the application, stimulation or redirecting forces within the craniofacial complex during use of functional or corrective appliances while guiding the dentition and its supporting structures to attain optimal occlusal relations, while maintaining physiologic and aesthetic harmony among facial and cranial structures.(6)

Orthodontics, like other fields has its fair share of controversies, haunting the profession since inception, though evolving from many years of clinical experience. In orthodontics there are few well-designed randomised controlled trials which is 'Gold standard' form of evidence. Recently, media attention has focused on views on the adverse effects of conventional orthodontic treatment much of which centring on the role of extracting teeth as part of orthodontic therapy to align teeth, retract protrusive incisors and to camouflage dentally any skeletal disharmonies between the mandible and the maxillae having little 'gold standard' evidence.(7)

Angle defined normal dental occlusion (1899) as a situation where "sizes, forms, interdigitating surfaces, and positioning of teeth in the arches such as to give to one another, singly and collectively, the greatest possible support in all directions", a picture of ideal occlusion, which is a rare fact, whereas normal occlusion contains minor deviations from the ideal dental relationships (Proffit 2013). In 1972, Andrews presented six keys that should be proper in normal occlusion: correct molar relationship, correct crown angulation, correct crown inclination, no rotations, no interdental spaces and flat occlusal plane, all of which are still applicable(Andrews 1972).

Malocclusion can be defined as appreciable deviation from normal or ideal occlusion (Andrews 1972). Malocclusions are classified into two major groups depending on skeletal relationships: Dental and Skeletal malocclusions. Severe malocclusions are often seen as skeletal and often referred to as 'dentofacial deformities' which are deviations from normal facial proportions and dental relationships severe enough to be handicapping (Proffit et al. 2003). In 1899, on the basis of sagittal relationships of the first molars, Angle described three classes of malocclusion (Class I; neutrocclusion, Class II; distocclusion, Class III;

mesiocclusion), which is still a commonly used method for registration of malocclusion, and the terms for incisor relationship have been adapted into classification (Class II division 1 and 2).

Though modern-day practice favours treatment during the growth phase, many severe cases still require surgical treatment in adulthood, the occurrence of severe malocclusions is also explained by limited access to orthodontic treatment during growth phase. Patients may have refused or interrupted treatment in adolescence, but sought treatment later on because of functional and/or aesthetic reasons, as well as the number of adults seeking orthodontic and orthodontic-surgical treatment has continued to increase (Nattrass & Sandy 1995, Buttke & Proffit 1999, Proffit et al. 2013.[8]

The American Association of Dental Research (AADR) recognizes that temporomandibular disorders (TMD) encompass a group of musculoskeletal and neuromuscular conditions that involve the temporomandibular joints, the masticatory muscles, and all associated tissues frequently associated with acute or persistent pain, and the patients often suffer some co-morbidities.[9] TMD is multi-factorial in aetiology; conditions involving trauma, anatomical, pathophysiological, and psychosocial factors [10,11]. Occlusal interferences, class II or III malocclusions, anterior open bite, excessive over-jet or posterior cross-bite have been related to TMD. Most importantly, orthodontic treatment as a contributing factor in development of TMD has been a subject of many studies, [12] which is still under discussion. Arguments against are based on the deleterious effects on stomatognathic function such as occlusal interferences, consequences of the use of inter-maxillary elastics, extra-oral forces or functional appliances. Several studies ,on the other hand, demonstrate no relation between orthodontics and TMD [13]. Signs and symptoms of TMD are relatively common on adolescents as several longitudinal studies show clinical signs of TMD, though inconsistent, increasing with age and appearing during the second decade of life [14,15].

Orthodontic treatment and TMD

In the late 1980s following a litigation that alleged that orthodontic treatment was the immediate cause of TMD in orthodontic patients, [16] the American Association of Orthodontists sponsored a series of risk management methods the results of which were published in January 1992 reporting orthodontic treatment generally is not a primary factor in TMD. Yet, unsettled as of now too, as the recent article of Thompson[17] indicates faulty intercuspation of the teeth and dental intrusions into

the freeway space as two of the many etiologic factors causing TMJ dysfunction and sequelae that follow.

"Functional orthodontists" opine that extracting premolars for orthodontic purposes lead to TMD because of over retracting the upper incisors during space closure, thereby forcing the condyle to take a posterior position within the fossa, which is likely to cause an anteriorly displaced disc leading to TMD[18] as was also believed that after orthodontic treatment if the position of the condyle was not 'rear most, mid most and upper most'. Roth demonstrated that the symptoms of TMD could be resolved once they were equilibrated with occlusal positioning splints [19]; therefore concluding that orthodontic treatment involving the loss of premolar teeth did not cause TMD which has been supported by other workers.[20, 21]

The final question addressed is the need to treat orthodontically to a 'functionally optimal occlusion', in terms of reducing tooth wear, TMD, periodontal disease, and instability of tooth position. Andrews' six keys to a normal occlusion as a means of obtaining a static intercuspal position that is seen as ideal, [22] which in practice is seldom achieved because of differences in skeletal pattern and tooth size discrepancies,[23] however, well intercuspated teeth are more stable and less likely to relapse.[24]

Disscussion of Review of Articles:

Temporomandibular disorders (TMD) and facial pain[8]

Clinical problems arising from the masticatory muscles, temporomandibular joints (TMJs), and associated structures are collectively called as TMD (de Leeuw 2008). The most important signs and symptoms of TMD include TMJ sounds, limited jaw opening capacity, deviations in mandibular movements, pain in masticatory muscles and TMJs and facial pain, (Okeson 2013). Signs and symptoms of TMD and facial pain can arise from malocclusion and dentofacial abnormalities (Panula et al. 2000, Abrahamsson et al. 2013), thus the common motivation to seek treatment (Forssell et al. 1998, Alanko et al.2010).

Malocclusion and TMD[25]

TMD can include masticatory muscle pain, internal derangement of the temporomandibular joint (TMJ) disc, and degenerative TMJ disorders as separate problems or can be a combination. In the untreated adult population, 26–59% reported at least one symptom and 48–86% show at least one clinical sign of TMD (Swanljung and Rantanen, 1979; Osterberg and Carlesson, 1979; Solberg et al., 1979; Pullinger et al., 1988). The etiology of TMD is complex and cannot be explained on a cause-and-effect basis, malocclusion

considered only as a contributing factor, not the sole etiological factor. Skeletal anterior open bite, reduced overbite, and increased overjet are associated with osteoarthritic TMJ patients with no evidence that overbite or overjet plays a role in the pathophysiology of non-arthritic disorders. Additionally, the presence of posterior crossbite does not initiate TMJ symptoms or disease (Seligman and Pullinger, 1991). Notable increases in risk occurred selectively with anterior open bite, unilateral maxillary lingual crossbite, overjet of more than 6–7 mm, more than 5–6 missing posterior teeth, and retruded cuspal position (RCP) to initial cuspal position (ICP) slides of more than 2 mm; overall contribution of occlusal factors being10–20%, while 80–90% related to other factors (Pullinger et al., 1993). In a review of the literature on this subject published between 1966 and 1988, Reynders[(26)] 91 publications were divided into three categories: viewpoint articles, case reports, and sample studies; the most numerous being viewpoint articles (n = 55), publications were anecdotal in nature, and little or no data was presented to support the opinion. Cross-sectional epidemiologic studies of specific adult non-patient populations show that at any given time, between 40% and 75% have at least one sign, and one third report no less than one symptom of TMD.[(27)]

A study conducted by Sadowsky and BeGoles at the University of Illinois on 75 adult subjects who, for at least 10 years, had been treated with full orthodontic appliances as adolescents. The treated group was compared to a group of 75 adults with untreated malocclusions resulting in an article by Sadowsky and Poison, the sample from the Illinois study (increased to 96 treated and 103 controls) was compared to a treatment group of 111 subjects who had been treated 10 years previously and a control group of 111 individuals with untreated malocclusions, findings providing evidence supporting the concept that orthodontic treatment performed during adolescence usually did not alter the risk of developing TMD sometime down the road.

Dahl and coworkers[(28)]examined 51 subjects 5 years after orthodontic treatment. Signs and symptoms of TMD were noted and contrasted to the findings from a comparable group of 47 untreated individuals. Statistically significant, mild symptoms (eg, joint sounds, muscle fatigue, stiffness of the lower jaw) were observed more frequently in the untreated group.

The investigation of Smith and Freer is one of a very few clinical studies reporting positive findings [(29)] examining 87 patients treated with full orthodontic appliances in adolescence. Soft clicks were

found in 64% of the treatment group and 36% of the untreated group. Interestingly, the authors closed the article by expressing: "The null hypothesis that there is a significant association between orthodontic treatment and occlusal or joint dysfunction has been rejected by nearly all previously reported studies and continues to be rejected by the present study."

Perspective articles and messages have emphatically connected the extraction of premolars with the occurrence of TMD in orthodontic patients[30-36]; these articles are long on opinion and short on conclusive data.

Dibbets and van der Weele[37] followed 111 of the original 172 orthodontic patients in the Groningen study over a 15-year time frame, in which group, a non-extraction approach was used in 34% of the patients, four premolars extracted in 29%, and other extraction patterns used in the remaining 37%. Functional appliances were used in 39%, fixed appliances (Begg) were used in 44%, and chin cups in 17%. These examiners noted that for a significant number of patients, symptoms of TMD appeared and disappeared over the span of study. In a 20-year follow-up, the difference had disappeared completely.[38] Several perspective articles[39-46] maintain that TMD may come about from a failure to treat orthodontic patients to gnathologic standards that include the establishment of a "mutually protected occlusion" and proper seating of the mandibular condyle within the glenoid fossa when contrasted to the more anterior position of the condyle advocated by the "functional orthodontists".

Regardless of noteworthy progress and advance in the diagnostic capabilities due to advanced techniques such as nuclear magnetic resonance imaging, 3D computed tomography, volumetric Cone-Beam tomography and application of more sophisticated clinical procedures, the conceivable relationship still remains hazy and a controversial region of debate reflecting in the way orthodontic treatment is considered. If, for some authors, orthodontic correction, may be the cure for TMJ dysfunction, for others it predisposes patients to pain and dysfunction of the stomatognathic system[47]). There is a difference in the quality of the designs of clinical studies before and during the 80s, and the most recent ones·[48]) Studies of cross sectional and observational nature, methodological errors, such as lack of information about randomization, blinding, sample size calculation, calibration, and control of factors as well as inadequate quality of study designs compromised the power in generating accurate scientific evidence. Lack of institutionalized standard

classification system and heterogeneity of results for TMD diagnosis added to the scenario.. Thus, there is always a scientific article to prove any point of view.[49]

When evaluating studies involving the interrelation of orthodontics and TMD, the diagnostic criteria adopted by the authors lack an universal classification system; diagnostic methods used by the authors of the included studies: Helkimo index,[50,51]) craniomandibular index,[52,53]and adaptations of these/other questionnaires. In order to standardize the diagnostic criteria and facilitate future clinical trials, the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) was formulated. [54] facilitating the use of standardized universal indices in the future. Studies also analyzed that the absence of TMJ sounds is not necessarily normal.[55,56]

Orthodontic mechanotherapy performs gradual changes in a system that has a great capacity of adaptation.[57] as obtained from few studies. [58] Some occlusal factors, such as skeletal anterior open bite, overjet greater than 6-7 mm, retruded cuspal position/intercuspal position slides greater than 4 mm, unilateral posterior crossbite and absence of five or more posterior teeth may be associated with specific diagnosis of TMD.[59]

Significant current scientific evidences, such as longitudinal and experimental-interventionist studies, point to a tendency of no association between orthodontic treatment and TMD,[60-67] the presence or absence of extractions during orthodontic treatment did not increase the prevalence or worsened signs and symptoms related to TMD.[61,64] Randomized clinical trials[66] and longitudinal prospective non-randomized studies,[60,61,62,64,65] as well as meta-analysis[68] and systematic review, besides presenting more rigorous methodologies, generated great scientific evidence. Moreover, the correct occlusal relationship between the teeth did not cause a change in the physiological position of the condyles and articular discs in TMJ when examined MRIs and CT.[69,70,71]

In relation to the role of therapy with Bionator[66] and headgear [66] it appears that they have no association with the development of TMD. It is important to be noted that the use of chin cup[72,73,74] and facial mask[75] shows weak or nonexistent associations in relation to TMD. On the other hand, results of a research examining the attitudes of Chinese orthodontists, regarding orthodontic treatment and TMD, using a questionnaire, showed that most orthodontists think that inadequate orthodontic treatment could increase the development of TMD and an adequate orthodontic treatment could prevent it.[76]

Treatment of severe malocclusions[8]

After growth has ceased, treatment of severe malocclusion is possible by either orthodontic treatment or combined orthodontic-surgical treatment. Orthodontic-surgical treatment is indicated when dentofacial problems are too severe to treat with orthodontics alone (Proffit & White 1990).

Oral habits: Habits like non-nutritive sucking, bruxisim, tongue thrusting, malpositioning of the tongue, self-injurious/self-mutilating actions, and OSAS cause unfavorable dental and facial development that is thought to be associational rather than cause and effect.[77, 78, 79] Reported complications of bruxism include dental attrition, headaches, temporomandibular dysfunction, and soreness of the masticatory muscles.[80] Habit treatment modalities like myofunctional therapy are [79] directed toward decreasing or eliminating habit and/potential deleterious effects like TMD. Endemic bruxism and clenching are etiologic factors in the development of TMD in the general population.[81] Seligman and Pullinger[82] state that reversible rather than non-reversible treatment should be provided to prevent or minimize possible harmful effects (TMD).

Crossbite: There is little evidence that this type of morphologic relationship leads to TMJ symptomatology. [83, 84]

Relationship between temporomandibular joint dysfunction (TMD) and open bite:[85]

Studies have related the morphologic aspects of malocclusion to mandibular dysfunction in children. [86-89] Williamson's survey on 304 pre-orthodontic patients between the age group of 6-16 showed that either open bite or deep bite caused pain dysfunction symptoms in 72%.[86] In a random sample of 402 children, Egermark-Ericksson et al [87] found a correlation between TMJ clicking and dental wear. [87] In a later longitudinal study on malocclusion in relation to signs and symptoms of TMD, the authors found that no single occlusal factor is of major importance in the development of TMD, but that morphological malocclusion such as crossbite and anterior open bite might be a potential risk factor [88]) In a larger longitudinal study with 7337 Japanese children, the prevalence of TMD was found to be 12.2%. In subjects with TMD, 72.9% exhibited some form of malocclusion and 5.4% had open bite. Because multiple subjects with TMD also had malocclusion, the authors recommended early treatment to prevent severe TMD [89].

Anterior open bite was not common in disc displacement disorders, with or without reduction. Further, Pullinger and coworkers [(90)] noted that most osteoarthrosis and myalgia patents did not present with anterior open bite. Pullinger and coworkers [(90)] stated that some large overjets in adults can be secondary to the condylar repositioning seen with advanced osteoarthrosis.

Unilateral Maxillary Lingual Crossbite: About 10% of adults in a given population show this occlusal feature presenting greater risk for assignment to the TMJ derangement groups. Nearly a quarter of the non-reducing disc displacement patients showed this feature, the odds ratio of an individual with this type of crossbite also presenting TMJ disc displacement with reduction being over 3:1. [(90)]

Class III malocclusion: Orthodontic treatment was not associated with the presence of TMD signs and symptoms and the non-working side contacts can be occlusal factors of risk. There was no significant difference in TMD prevalence between the studied groups (orthodontically treated patients and patients treated with orthodontics followed by orthognathic surgery).[(91)]

Orthodontists have no doubts about the effectiveness of functional appliances; yet many authors assert that treatment with these devices does not increase the prevalence of temporomandibular disorders. [92,93-95] Another important aspect is the positive or negative effect that functional appliances may have on the TMJ of patients with a pre-existing disorder[92].

Conclusions:

Areas of smouldering controversy have been chosen, reviewed from various articles, and concise points that are relevant to the topic have been put together not to rekindle historic arguments or generate a new turf war but to illustrate the somewhat flimsy evidence both sides of an argument can use. Many of the available studies in literature have limitations in their designs and methodologies, as well as heterogeneity of results, which reduces the power of evidence generated. Future research should be directed toward developing a more complete understanding of these occlusal factors so that reliable criteria can be developed to assist the dental practitioner in deciding when dental therapy plays a role in the management of TM disorders, thus sparing many TMD patients significant dental therapies and related health costs. Until such criteria are developed, the dental profession should be encouraged to manage TMD

symptoms with reversible therapies, only considering permanent alterations of the occlusion in patients with very unique circumstances.[96]

Thus, concluding that according to the existing literature, the relationship of TMD to occlusion and orthodontic/orthognathic treatment is minor. The vital question that still remains in the minds of younger researchers is how this minor contribution can be identified, enable harmonization, with long-term, standardized follow-up studies to obtain more precise conclusions about the role of these treatment modalities in relation to TMD.

Conflict of Interest: Nil

Source of Funding: Self-funded

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