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Impact of orthodontic treatment on temporomandibular disorder – a systematic Review

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ABSTRACT

Objective: To evaluate the possible association between malocclusions, orthodontic treatment and development of temporomandibular disorders.

Materials and Methods: A web-based search was carried out using electronic databases such as PubMed, Science Direct and Google scholar between the year 2007 to 2022 with a focus on longitudinal studies, Prospective, Case-control, Retrospective and Randomized Controlled Trials.

Results: 60 studies were searched in which 22 articles have been selected based on inclusion criteria. Among these studies, 2 were randomized controlled trials, 16 were prospective longitudinal studies without randomization and 5 were retrospective studies.

Conclusions: After a detailed review of the studies found in the latest literature, it has been concluded that association between different types of orthodontic treatment and the development of TMD signs and symptoms could not be established. There is no evidence for a direct cause-effect relationship between the orthodontic treatment and TMD.

Keywords: Orthodontic treatment, Temporomandibular joint, Magnetic Resonance Imaging, Computed Tomography, Cone Beam Computed Tomography**.**

I. INTRODUCTION

The temporomandibular joint (TMJ) is the joint between the lower jaw and the base of the skull. TMJ disorders (TMD) refer to a group of disorders with symptoms that include pain, clicking, grating in the jaw joint or problems with chewing or opening the jaw. This condition can be known by a variety of conditions including craniomandibular disorders (CMD) and is a frequent cause of facial pain problems.[1] Theopinion that orthodontic treatment cancause temporomandibular disorders (TMD) is widespread among general dental practitioners. Likewise, this has been frequently mentioned in literature, and some studies done by Franks [2]are often used to support this statement.

The role of morphological and functional occlusion in the development of TMD has been matter of debate for a long time. Occlusal interferences, class II or III malocclusions, anterior open bite, excessive overjet or posterior crossbite have been related to TMD. Furthermore, orthodontic treatment as a contributing factor for the development of TMD has been the subject of many studies, [4] especially after the Michigan Court in 1987, when an orthodontist was damned to pay a $850,000 compensation to a patient as he was considered main responsible of the TMD developed after the orthodontic treatment.[5] Nevertheless, this topic still remains under discussion. Arguments against the orthodontic treatment are usually based on the deleterious effects on stomatognathic function such as occlusal interferences, consequences of the use of intermaxillary elastics, extra oral forces or functional appliances. On the other hand, several studies demonstrate no relation between orthodontics and TMD.[6]

The question about the possible correlation becomes even more confusing since the opposite opinion, that orthodontic treatment can cure and/or even prevent TMD, has also been claimed. It has been stated, for instance, that "if we have the concept of building an occlusion to fit the mandible mechanism, the TMJ pain-dysfunction syndrome can be virtually eliminated in the post-orthodontic patient. During the years a great number of papers have focused on the possible negative or positive relations between orthodontic treatment and TMD.

The aim of this systematic literature review is to answer the following question: Is there any association between the signs and symptoms of TMD and orthodontic treatment?

II. MATERIAL AND METHOD:

An electronic research was conducted in PubMed-Medline databases covering the period from January 2007 to Dec 2022 using as keywords "orthodontics and temporomandibular disorders", "orthodontics and facial pain", "malocclusion and temporomandibular disorders", "orthodontics and

temporomandibular disorders treatment". A total of 60 articles were searched using electronic databases such as PubMed, Science direct and Google scholar. Only published articles from 2007 to 2022 were included. Articles like literature reviews, editorials, letters to the editor, experimental studies with animals and short communications were excluded from this review. Prospective, longitudinal, case-control or retrospective studies with larger samples and significant statistical analysis were included. These studies are the level B of evidence (moderate evidence). Studies that dealt with deformities and craniofacial syndromes or treatment by means of orthognathic surgery were also excluded.

III. RESULT:

There were 22 articles out of 60 studies found relating orthodontics to TMD according to the inclusion criteria. Among these studies, 2 were randomized controlled trials, 16 were prospective longitudinal studies without randomization and 5 were retrospective studies. Among all articles selected 2 were based on Magnetic Resonance Imaging, 9 were based on CBCT images, 3 were on CT scan and 8 were based on lateral cephalometric radiographs. Table 1 presents a description of the studies found.

None of the selected articles found a deleterious effect of orthodontic treatment on TMJ. Kurt. H et al[19] found that orthodontic treatment could reduce sign and symptoms of TMJ. Majority of them showed a relationship between TMD and female sex and a fluctuation of its manifestation over time. The difference in TMD between those with and without malocclusion was small. Subjects with untreated crossbites, crowding or large overjet showed a higherprevalenceand higher sign and symptom of TMD.[2,7,8,11]

Table 1.

Studies based on radiographic methods used for assessment.

S. No.	Study Title and Authors	Appliance used / class of malocclusion	Study Design	Sample Size and study Population	Clinical / Radiological assessment	TMJ Changes
1.	Temporomandibular joint fossa difference according to the skeletal malocclusion [8]	Class I, Class II and Class III malocclusion.	P	20 Korean subjects in each group.	CBCT	Statistically significant (P < 0.05 Ant. fossa point to post. fossa point distance. External auditory canal wall thickness Height and inclination of articular eminence.
2.	TMJ changes after maxillary protraction in children with class III malocclusion [9]	Facemask	PL	18 Korean subjects	CBCT	Superior and posterior rotation of the condyle.
3.	TMJ evaluation in Class I and Class II malocclusion subjects [10]	Class I and Class II malocclusion	PL	49 Brazilian subjects	CBCT	Prominent convex condylar shape.

4.	Three-dimensional assessment of TMJ is skeletal Class I, Class II and Class III malocclusion [11]	Class I, Class II and Class III malocclusion	PL	60 Egyptian young adult subjects of 18 – 25 years old among which 20- skeletal class I 20- skeletal class II 20- skeletal class III.	CBCT .	Class II patients revealed lowest condylar width, highest condylar height and anterior joint space. The condylar position was most inferior. Class III patients revealed lowest superior, anterior and medial joint spaces and the width mandibular fossa and anteroposterior dimension of the condyle was highest. The position of the condyle was most superior.
5.	Assessment of Condyle and glenoid fossa morphology in South East Asians [12]	All types of Malocclusion	PL	100 Malay subjects	CBCT	Higher condylar height, width and volume.
6.	Three-dimensional assessment of the temporomandibular joint and mandibular dimension in patients with Class II division 1 or division 2 malocclusion [13]	Class II division 1 and division 2 malocclusion	PL	28 Turkish Patients Group I- 14 patients Group II- 14 patients	CBCT	No effect on TMJ
7.	Camouflage treatment with multiloop edgewise arch wire appliance and modified class III elastics by maxillary mini implant	Multiloop Edgewise Arch wire (MAEW Mini-Implants Class III elastics	PL	44 Chinese subjects	Lateral Cephalograms	Increased Mandibular angle

	anchorage [14]					
8.	Comparison of the condyle-fossa relationship between skeletal class III malocclusion patients with and without asymmetry [15]	Skeletal Class III malocclusion	R	Group 1 consists of 40 Korean subjects with normal occlusion. Groups 2 and 3 consists of patients with skeletal class III.	CBCT	No significant changes were observed in all the groups except in group 3 which showed steeper axial condylar angle.
9.	Non-surgical treatment of class III malocclusion in adults [16]	Modified fixed reverse twin block appliance	PL	32 Chinese subjects	Lateral Cephalograms	Condylar displacement anteriorly and posteriorly. Retruded position of the mandible.
10.	Condylar volume and condylar area in Class I, Class II and Class III young adult subjects [17]	Class I, class II and Class III malocclusion	R	200 Caucasian patients	CBCT	Condylar Volume and area were higher in Class III group.
11.	Three-dimensional assessment of mandibular and glenoid fossa changes after bone-anchored Class III intermaxillary traction [18]	Class III intermaxillary elastics and bilateral miniplates Class III malocclusion of both skeletal and dental origin.	PL	25 Caucasian patients (13 girls, 12 boys age between 9 and 13 years.	CBCT	Mandible was posteriorly displaced in all subjects (mean of posterior ramus, 2.74 ± 1.36 mm; condylar mean, 2.07 ± 1.16 mm; mean of the chin, −0.13 ± 2.89 mm). Glenoid fossa remodeling takes place at the anterior eminence (mean, was 1.38 ± 1.03 mm) and bone resorption takes place at the posterior wall (mean was, −1.34 ± 0.6 mm) in most of the patients.
12.	The effects of two methods	Class III malocclusi	RCT	46 Turkish patients	Lateral Cephalogra	No statistically significant

	of Class III malocclusion treatment on temporomandibular disorders [19]	on			ms	differences
13.	Changes in temporomandibular joint disc position and form following Herbst and fixed orthodontic treatment [20]	Herbst and Fixed Class II division I and Mandibular retrognathism	PL	32 Brazilian adolescent subjects- 16 boys and 16 girls with Mean age: 12.8 ± 1.2 years	MRI	42 Joints showed superior disc position and in T2 the disc tend towards retruded position with regard to the condyle while closing the mouth. In open mouth position the disc was, in between the articular eminence
14.	Effects of two types of Facemasks on Condylar Position [21]	Delairs and Grummons Protraction Facemasks	PL	34 Turkish Patients treated with protraction facemask. Divided into two groups: Group I- 18 patients treated with Delaire facemask. Group II- 16 treated with Grummons facemask.	Lateral Cephalograms	Downward and forward movement from centric relation to maximum intercuspal position for both condyles at the start of treatment for most patients. After the treatment, difference between centric relation and maximum intercuspation was decreased in the group I than in the group II.
15.	CT evaluation of TMJ in Class II div I patients and Class III malocclusion [22]	Class I malocclusion	P	30 Italian patients	CT scan	Higher Post. articular space in both right and left sides.
16.	Three-dimensional evaluation of TMJ parameters in Class II and Class III patients [23]	Class II and Class III Malocclusion	PL	15 European subjects with skeletal Class II their mean age was 18.0 years. 14 patients with skeletal Class III with	CT Scan	length of the processuscondylaris was increased in Class III cases.

				the mean age of 19.2 years.		
17.	Effects of fixed functional appliance treatment on TMJ [24]	Fixed Functional appliance-Forsusnitinol flat spring class II div I with Mandibular retrusion.	RCT	60 Turkish patients in which 30 patients randomly selected treated with appliance. 30 patients in control group. Mean age- 12 years 7 months.	CT Scan	Significant differences ($P < 0.05$)c were observed in anterior and Posterior joint spaces. Condyles were more backwardly placed in the study group.
18.	Evaluation of TMD in Class III patients treated with Mandibular Cervical Headgear and Fixed appliances [25]	Mandibular Cervical Headgear and Fixed appliances	PL	75 Italian subjects	Lateral Cephalograms	No Statistically significant.
19.	‘‘Effective’’ TMJ and Chin Position Changes in Class II Treatment [26]	Tip edge Multibracket with Class II elastics. Herbst appliance	R	64 German patients Group 1 - 24 patients Group 2 – 40 patients	Lateral cephalograms	Favorable TMJ and chin position changes with Herbst
20.	Mandibular Asymmetry in Different Occlusion Patterns [27]	Class I, Class II Div1 , Class II Div2, Class III malocclusion and Normal occlusion.	R	189 Turkish patients Group 1 (Class I- 39 Group 2 (class II/1)-43 Group 3 (class II/2)-39 Group 4 (Class III)- 42 Group 5 (Control)- 26	Lateral Cephalograms	Higher condylar asymmetry in class II/1 group.
21.	Topography and Morphology of the Mandibular Condyle during Fixed functional orthopaedic treatment [28]	Fixed Functional appliance	PL	20 German Patients	MRI	No adverse effect
22	Correlation between temporomand	intraoral examination with a	R	374 adult patients (244 females	Lateral Cephalograms	The association between class I, II, III

	ibular disorders and malocclusions	gnathological assessment		and130 males).		malocclusions and the presence of TMD was found to be statistically significant: p<0.0001 (OR= 4.04) and that between open/deep bite and the presence of TMD too: p= 0.003 (OR= 1.89).

IV. DISCUSSION:

TMD has a multifactorial etiology because itis a complex structure affected by a variety of variables. The role of orthodontics in the development of temporomandibular joint disorder has been speculated for many years.The restrictions imposed in this study in relation to databases and languages in the search of the literature relating to TMD and Orthodontics may have resulted in few studies. However, finding the best evidence, prioritizing the quality of the studies and the diagnosis of TMD and its division into subtypes could lead to clearer conclusions about this association.

It is very much necessary to assess the recent literature in a critical and proper way to determine what level of scientific evidence that the information generates. The application of methodological considerations for research such as sample size determination, randomization, blinding and control of involved elements are essential to qualify the level of evidence generated. And this information must be available for evaluation and discussion for the researcher.[29]

MRI and CT are methods with greater diagnostic accuracy compared with conventional radiography, because of higher anatomic resolution. CT is the ideal method for evaluation of bony structures, while MRI allows the study of soft tissues, including articular disc. Both methods often augment the study of abnormalities of the temporomandibular joint (TMJ), thus becoming vital tools in the differential diagnosis of various diseases in TMJ area [30].

From early retrospective investigations of previously treated patients. [3, 4, 5]It was concluded that patients that underwent orthodontic treatment do not exhibit more signs or symptoms of TMD comparedto untreated individuals. However, from the findings in later prospective studies[4] it can be speculatedthat the similarities regarding TMD in patients and controls found in the early retrospective studies was in fact that the consequence of an improvement of TMD among those patients treated, making them, in respect of TMD, equal to individuals subjected to orthodontic treatment.

In view of the present knowledge, it was impossible to identify if posttreatment relapse was the result oforthodontic treatment alone or of physiologic changes in the dentition and surrounding tissues during the follow- up period. It has been shown that craniofacial alterations occur in adults and are accompanied bycompensatory changes in the dentition.[31,32]To evaluate the relapse, where several factors may act at different time intervals together with natural craniofacial alterations and compensatory changes in the dentition, the researchers have to focus on and use prospective well-designed follow-up studies with untreated controls. Efforts should be made to avoid bias by using well-defined and sufficiently large samples. Today, the systematic literature search, data extraction, and subsequent quality assessment of included studies are well-established measures in evidencebased medicine and dentistry. However, the precise methods for the process can differ among various systematic reviews.

A study revealed that the growth due to bone-anchored maxillary protraction and response to orthodontic treatment resulted in bone apposition at the anterior wall of the articular eminence which corresponds to posterior displacement of the anterior condylar region, and bone resorption at the posterior wall of the articular eminence corresponds well with the posterior displacement of the posterior condylar region. This high degree of association between modeling at the posterior and anterior glenoid fossa eminences and the resultant displacement of the opposing surfaces of the condyle suggested that the anteroposterior chin displacement was not due to a positional

mandibular shift between pre and post treatment. However, this bone remodeling is due to the combined effect of orthopedic traction and normal growth.[19]

Whether mandibular growth is reduced or deflected by using chin-cup has been a matter of debate in previous literature, and the method by which a chin-cup therapy results in development of skeletal Class III malocclusion is still not clear. It is widely accepted that mandibular growth is altered mainly due to condylar growth. However, it has been emphasized that growth of the condyle is not a distinctive feature in craniofacial growth and development. Hence, it would be considered as one of the factor which attributes growth of the mandible only to condylar growth.[33, 34]In chin-cup treatment, an orthopedic force is directed backwards and upwards on the TMJ, with pressure exerted from the chin to the condylar region. Forces that are applied in posterosuperior direction have been pretended to be the contributing factor for development of TMD[34].

It is necessary to take into account the fluctuating nature of TMDs, which could be wrongly attributed to be caused or aggravated by orthodontics due to the fact that this is the period of the life when this treatment is usually carried out.[35]Epidemiological studies like Magnusson et al.[36] revealed a high prevalence of signs and symptoms of TMD, especially TM joint noises, in children and young people, with the greatest prevalence in those aged between. Due to this fluctuating and unpredictable behaviour of the TMD, it results of utmost importance to properly inform the patients about the high prevalence of this condition and its multifactorial nature, which makes difficult to establish an association with the orthodontic treatment performed. Therefore, the continuous monitoring of TMJ is essential to detect the onset of a TMD as early as possible. In these cases it is recommended to temporarily stop orthodontic treatment in order to avoid possible aggravating factors until signs and symptoms, especially pain, improve. Otherwise, if TMD is diagnosed in the first evaluation of the patient, the orthodontic treatment should not be initiated, according to Michelotti et al. [32] as long as the patient suffers from a facial pain. In both cases, the priority should be the differential diagnosis between musculoskeletal condition and another diseases and the management of the TMD would include the use of occlusal splints to evaluate the interference-free position of the mandible, pharmacotherapy, behavioral therapy, and/or physical therapy.

V. CONCLUSION:

From the studies found in the literature review, we concluded that the orthodontic treatment, regardless of the technique used and whether or not the extraction of premolars during treatment, does not increase the signs and symptoms of TMD. Therefore it is not a risk factor for its development. The orthodontic treatment does not appear to be a valuable resource for treating or preventing the onset of signs and symptoms of TMD. There is the need to improve the methodology used in studies that seek to demonstrate the association between TMD and orthodontic treatment so they can be less contradictory. Features such as controlled trials, longitudinal studies and tools that can diagnose TMD and divide it into subtypes (such as muscular, articular and mixed), seem to be necessary for a better understanding of this association

REFERENCES

[1]. Dworkin SF, LeResche L. Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. Journal of Craniomandibular Disorders 1992;**6**(4):301–55.
[2]. Franks AS. The dental health of patients presenting with temporomandibular jointdysfunction. Br J Oral Surg. 1967;5(2):157-66.
[3]. Chandwani B, Cneviz C, Mehta N, Scrivani S. Incidence of bruxism in TMD population. N Y State Dent J. 2011;77:54-7.
[4]. Luther F. TMD and occlusion part I. Damned if we do? Occlusion: the interface of dentistry and orthodontics. Br Dent J. 2007;13:202-209.
[5]. Pollack B. Cases of note. Michigan jury awards $850.000 on ortho case: a tempest in a teapot. J Mich Dent Assoc. 1988;70:540-2.
[6]. Bourzgui, Sebbar M, Nadour A, Hamza M. Prevalence of temporomandibular disfunction in orthodontic treatment. IntOrthod. 2010;8:386-98.
[7]. Aubrey RB. Occlusal objectives in orthodontic treatment. Am J Orthod. 1978;74(2):162-75.
[8]. Paeng, J., et al., Temporomandibular joint fossa difference according to the skeletal malocclusion. Int J Oral Maxillofac., 2017. **46**: p. 362
[9]. Lee, H., et al., Three-dimensional changes in the temporomandibular joint after

maxillary protraction in children with skeletal class III malocclusion. J Oral Sci, 2016. **58**(4): p. 501-508.
[10]. Merigue, L.F., et al., Tomographic evaluation of the temporomandibular joint in malocclusion subjects: condylar morphology and position. Braz Oral Res, 2016. **30**(1).
[11]. Alhammadi, M.S., M.S. Fayed, and A. Labib, Three-dimensional assessment of temporomandibular joints in skeletal Class I, Class II, and Class III malocclusions: cone beam computed tomography analysis. J World Fed Orthod, 2016. **5**(3): p. 80-86.
[12]. Al-koshab, M., P. Nambiar, and J. John, Assessment of condyle and glenoid fossa morphology using CBCT in South-East Asians. PloS one, 2015. **10**(3): p. e0121682.
[13]. Coskuner, H.G. and S. Ciger, Three-dimensional assessment of the temporomandibular joint and mandibular dimensions after early correction of the maxillary arch form in patients with Class II division 1 or division 2 malocclusion. Korean J Orthod, 2015. **45**(3): p. 121-129.
[14]. He, S., et al., Camouflage treatment of skeletal Class III malocclusion with multiloop edgewise arch wire and modified Class III elastics by maxillary mini-implant anchorage. The Angle Orthod, 2013. **83**(4): p. 630-640.
[15]. Kim, H.O., et al., Comparison of the condyle-fossa relationship between skeletal class III malocclusion patients with and without asymmetry: a retrospective three-dimensional cone-beam computed tomograpy study. Korean J Orthod, 2013. **43**(5): p. 209-217.
[16]. Liu, H. and J.-X. Li, Non-surgical treatment of an Angle Class III malocclusion in adults. Int J ClinExp Med, 2013. **6**(9): p. 738-746.
[17]. Saccucci, M., et al., Condylar volume and condylar area in class I, class II and class III young adult subjects. Head face Med, 2012. **8**(1): p. 34.
[18]. De Clerck, H., et al., Three-dimensional assessment of mandibular and glenoid fossa changes after bone-anchored Class III intermaxillary traction. Am J OrthodDentofacialOrthop, 2012. **142**(1): p. 25-31.
[19]. Kurt, H., et al., The effects of two methods of Class III malocclusion treatment on temporomandibular disorders. Eur J Orthod, 2011. **33**(6): p. 636-641.
[20]. Aidar, L.A.A., et al., Changes in temporomandibular joint disc position and form following Herbst and fixed orthodontic treatment. Angle Orthod, 2010. **80**(5): p. 843-852.
[21]. El, H. and S. Ciger, Effects of 2 types of facemasks on condylar position. Am J OrthodDentofacialOrthop, 2010. **137**(6): p. 801-808.
[22]. Rodrigues, A.F., M.R. Fraga, and R.W.F. Vitral, Computed tomography evaluation of the temporomandibular joint in Class II Division 1 and Class III malocclusion patients: condylar symmetry and condyle-fossa relationship. Am J OrthodDentofacialOrthop, 2009. **136**(2): p. 199-206.
[23]. Krisjane, Z., et al., Three-dimensional evaluation of TMJ parameters in Class II and Class III patients. Stomatologija, 2009. **11**(1): p. 32-6.
[24]. Arici, S., et al., Effects of fixed functional appliance treatment on the temporomandibular joint. Am J OrthodDentofacialOrthop, 2008. **133**(6): p. 809-814.
[25]. Rey, D., G. Oberti, and T. Baccetti, Evaluation of temporomandibular disorders in Class III patients treated with mandibular cervical headgear and fixed appliances. Am J OrthodDentofacialOrthop, 2008. **133**(3): p. 379-381.
[26]. Serbesis-Tsarudis, C. and H. Pancherz, "Effective" TMJ and chin position changes in Class II treatment: orthodontics versus orthopedics. Angle Orthod, 2008. **78**(5): p. 813-818.
[27]. Sezgin, O.S., P. Celenk, and S. Arici, Mandibular asymmetry in different occlusion patterns: a radiological evaluation. Angle Orthod, 2007. **77**(5): p. 803-807.
[28]. Kinzinger, G., C. Kober, and P. Diedrich, Topography and morphology of the mandibular condyle during fixed functional orthopedic treatment–a magnetic resonance imaging study. J OrofacOrthop, 2007. **68**(2): p. 124-147.
[29]. Machado, E., R.A. Grehs, and P.A. Cunali, Imaging from temporomandibular joint during orthodontic treatment: a

systematic review. Dental Press J Orthod, 2011. **16**(3): p. 54-56.

[30]. Garcia, M.d.M., K.F.S. Machado, and M.H. Mascarenhas, Magnetic resonance imaging and computed tomography of the temporomandibular joint: beyond dysfunction. RadiologiaBrasileira, 2008. **41**(5): p. 337-342.

[31]. Behrents RG. Growth in the Aging Craniofacial Skeleton. Ann Arbor, Mich: Center for Human Growth and Development; 1985. Craniofacial Growth Series, Monographs 17 and 18.

[32]. Forsberg CM, Eliasson S, Westergren H. Face height and tooth eruption in adults—a 20-year follow-up investigation. Eur J Orthod. 1991;13:249–254

[33]. Koski, K., Cranial growth centers: Facts or fallacies? Am J OrthodDentofacialOrthop, 1968. **54**(8): p. 566-583.

[34]. Zurfluh, M.A., et al., Effect of chin-cup treatment on the temporomandibular joint: a systematic review. Eur J Orthod, 2015. **37**(3): p. 314-324.

[35]. Henrikson T, Nilner M, Kurol J. Signs of temporomandibular disorders in girls receiving orthodontic treatment. A prospective and longitudinal comparison with untreated Class II malocclusions and normal occlusion subjects. Eur J Orthod. 2000;22:271-81.

[36]. Magnusson C, Nilsson M, Magnusson T. Degenerative changes of the temporomandibular joint. Relationship to ethnicity, sex and occlusal supporting zones based on a skull material. ActaOdontol Scand. 2012;70:207-12.

[37]. Michelotti A, Iodice G. The role of orthodontics in temporomandibular disorders. J Oral Rehabil. 2010;37:411-29.

[38]. Mohamed ZahoorUl Huqh1 etalEffect of Orthodontic Treatment on Temporomandibular Joint. A Review.Eur J Molecular & Clinical Med Volume 07, Issue 11, 2020

[39]. Alessandro Marchesi*,Correlation between temporomandibular disorders and malocclusions: A retrospective observational study-can malocclusions or previous orthodontic treatments affect Temporo- Mandibular Disorders?Int J Oral CraniofacSci 8(1): 001-009, 2022