EVALUATION OF IDIOPATHIC SCOLIOSIS PATIENTS IN TERMS OF TEMPOROMANDIBULAR JOINT DISORDERS: A PILOT STUDY

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SUMMARY

Objective. The aim of this study was to investigate the type and incidence of TMD in adolescents with idiopathic scoliosis (IS) disease.

Methods. The sample consisted of 50 patients, selected using simple random sampling, and included 26 females and 24 males (mean age: 13.5 ± 2.1 years) from Department of Orthopaedics and Traumatology, Faculty of Medicine, Istanbul University. Diagnostic Criteria for Temporomandibular Disorders: Clinical Protocol and Assessment Instruments (DC/TMD) form was utilised to assess the signs and symptoms of TMD in idiopathic scoliosis patients. The pressure pain threshold (PPT) values for the muscles were measured through a hand-held pressure algometer. Parameters and obtained values were evaluated statistically by using paired samples t-test and independent samples t-tests.

Results. According to the results, 94.7% of the samples had pain related TMD, 36.8% had headache on temporal region, and 81.6% had no intra-articular or degenerative joint disorder. A statistically significant difference was found regarding muscular TMD between genders (Female: 95.2%, Male: 68.2%) (p=0.02). In patients with myalgia, it was determined that the most painful muscle was the masseter.

Conclusion. It can be concluded from this study that diseases which can cause postural changes like scoliosis in the region of the head and shoulders have relationship to the adaptation of the muscles and following alterations in the temporomandibular joint (TMJ) area. Therefore, patients with IS should be routinely controlled in terms of TMD and necessary measures should be taken early to reduce the need for further treatment options.

Key words: adolescent, temporomandibular disorders, bruxism, stress, lifestyle modification/health behavior change, epidemiology.

Introduction

The influence of spinal deformities on temporomandibular joint disorders (TMD) is a continually discussed subject with contrasting results and there is still no consensus about it.

Temporomandibular disorder (TMD) is a status that influences the temporomandibular joint (TMJ) and/or the muscles of mastication and incorporated structures. It could be categorized with respect to its origin in muscle disorders, joint disorders or mix type (1-5). TMD has a multifactorial etiology generally including local, psychological, and sensual determinants. Determinants generally associated with TMD are incorrect oral habits, malocclusions, missing teeth, emotional stress, joint pathology or trauma, parafunctional activities, bad posture, and others (6, 7).

The symptoms of TMD are headache, joint sounds, pain, alterations in functional dynamics, limitation of mandibular movements and other changes in muscle tonus (8). Although the pain and restriction of the mandibular opening are the main complaints of TMD, these may be accompanied by muscle tiredness and deviation in the spine axis and, consequently postural problems (9). TMD patients overloads the cervical muscles by virtue of enhanced activity of the masticatory muscles in order to equalize the disorder (10). This kind of overload may conclude in mandibular and spinal deviations, like cervical hyperlordosis, as there is head protrusion and shoulder elevation in TMD patients. These spinal deviations, which are also present in scoliosis, raise the question whether this disease is related to TMD or not. However, there is not sufficient data about this subject in the literature.

IS has equal epidemiologic characteristics – stability of the developed deformation types, incidence and appearance time – with kyphosis (11). The frequency of IS changes between 11.9 and 16.2%. The main curvature could be present in any division of the vertebral column, the most known existing the right convex dorsalis scoliosis, which in the non-balanced types causes a left-inclined head position and postural changes. Its progress begins throughout pre-puberty, and 7 to 10 times more than boys in girls. In the early phase, the conservative treatment of this spinal disease comprise posture supporting and developing the muscle tonus by physiotherapy. But in the late phase, in severe types, corset wearing is essential, due to the Cobb value of > 20° in patients with SC (12).

In the literature, it is mentioned that bad posture influences the muscles and tendons, and affects mandibular position, concluding alterations in the TMJ that may be related with joint dysfunction. Some of the studies in the literature (13, 14) have indicated that postural alterations of the head and cervical spine function overburden the TMJ and treat like a regular causal agent of TMD, while others did not demonstrate any relevance (15, 16), therefore underlining the requirement for further studies on this issue.

The role of head position inclined backward and forward that developed as a result of the pathological curves of the sagittal plane (lordosis and kyphosis) has been mostly investigated in the development of the vertical and sagittal jaw anomalies (17). According to present studies, the scoliotic curves of the frontal plane, due to the head position inclined side long, act a role in the formation of the several dentofacial asymmetries (18, 19). Alterations in the head position can cause the growth of TMD and constructive deformity.

According to the contradictory situations mentioned above and the present studies, there is no attempt to evaluate the possible relationship between IS and TMD. Therefore, in this study, it's aimed to find an answer to this question and collect data for further related studies about this topic. The null hypothesis is that TMD incidence in adolescents is not correlated with IS.

Methods

The Ethics Committee of the Istanbul University Faculty of Dentistry confirmed this research under protocol number 2017/49. Patients attending the study received detailed information about the procedures formerly, and their caregivers provided written informed consent for participation.

Based on a preliminary pilot study, a power analysis was performed using G*Power(v3.1.7) to determine the necessary sample size required to achieve a minimum 80% power with an alpha error probability of 5%; this generated a sample size of at least 26 participants. A simple random sampling were used to recruit participants for the study.

All the patients had to meet the consequent inclusion criteria: diagnosis of IS, being under 18 years, absence of pregnancy, absence of spontaneous pain (myogenous pain at rest or without specific occasions), having good general health conditions according to medical history, absence of trauma which could affect postural position, absence of distinct postural problems, absence of dentofacial deformity, absence of ongoing orthodontic treatment or former orthodontic tre-

atment on the last 3 years and absence of neurological disorders. Patients who had congenital or acquired skeletal abnormalities, earache or headache, mental disorders or who were undertaking any physical therapy for postural alteration or had back surgery were excluded from the study due to the impact on the results.

For the study, 57 patients with diagnosed IS were referred by the Department of Orthopaedics and Traumatology, Faculty of Medicine, Istanbul University. Seven of these patients were excluded from the study, as 2 of them had ongoing orthodontic treatment and 5 had back surgery for scoliosis treatment. Remaining 50 patients (mean age: 13.5 ± 2.1 years) underwent a TMD clinical diagnosis according to the Diagnostic Criteria for Temporomandibular Disorders: Clinical Protocol and Assessment Instruments (DC/TMD). For the evaluations on muscles, upper trapezius muscle and SCM (sternocleidomastoid muscle) were added to the category during examination as a 'supplemental muscle group' upon complaints of the patients. According to these criteria, individual records of each patient examined were formed and data records were obtained to investigate the effect of age, sex, and clinical status on the possible relationship of IS and TMD.

In addition to the DC/TMD criteria, pain on the head and neck muscles during the clinical examination were assessed by obtaining pressure pain threshold (PPT) measurements which were taken from the points listed in Table 1 with a hand-held algometer (Force Dial model FDK 40 Push Pull Force Gage; Wagner Instruments, Riverside, CT, USA). The PPT was bilaterally assessed by applying pressure to following four muscles in a random sequence for three consecutive series: masseter, temporalis, SCM, and upper trapezius. The examiner was formerly trained to perform a constant pressure of about 1 kg/cm^2/s with optimal positioning of the device vertically to the evaluated anatomical surfaces. A 90.8% specificity value was used to determine the appropriate PPT cut off values for all muscles studied. The examination of the above mentioned muscles was applied extraorally by the same examiner and interval rate between the examination of the right and left sides was five-second. A digital metronome was used in all evaluations for providing an audio feedback and standardization of the pressure application speed to the examiner. Participants were informed that the evaluation was to define the pain threshold and not to measure pain tolerance; so, they were asked for signaling as soon as they first felt pain. All participants were firstly trained with a first assessment on the right hand's thenar region.

All the data obtained after the end of these tests were recorded and separate files were prepared for each patient.

Statistical analysis

The IBM SPSS V23 software package (IBM Corp., Armonk, NY, USA) was used for data analysis.

Descriptive information was presented as a percentage or as mean ± standard deviation. Paired samples t-test was used to examine differences

Table 1 - Anatomical sites of PPT (Pressure Pain Threshold) assessment of the muscles.

Name of evaluated muscle	Segments
Masseter	Origin, body, and insertion
Temporalis	Anterior, middle, and posterior
SCM†	Upper, middle, and lower
Upper trapezius	Midpoint between C7 and acromion

SCM†: Sternocleidomastoid muscle

of values in right and left sides. Mean values of painless opening and maximum unassisted opening according to sex were analyzed using independent samples t test and two proportion t-test was used to compare differences. Significance levels were set at $p \leq 0.05$.

Results

The results showed that the examined patients had more symptoms in terms of muscular region than the intra-articular factors. According to the Axis-1 assessment of DC/TMD form, the percentage of those who had pain on any side in the last 30 days in the jaw, in the temple, in the ear or in front of the ear was 26.3%. The group of patients describing the pain was reported to have the most pain as a result of the following activities: chewing hard or solid food (10.5%) and masticatory habits such as constantly touching teeth, clenching or chewing gum (10.5%).

In the present study, 63.2% of the patients gave no answer to the questions about the presence of the headache. The part of the patients that reported any joint sounds when the jaw was moved or used constituted an area of 21.1%, and this applied equally to the right and left sides. The proportion of those who said 'yes' to the question of 'Have you ever had your jaw lock or catch, even for a moment, so that it would not open all the way?' was 21.1%. The rate of those who said 'no' to the question that mentioned 'Was your jaw lock or catch severe enough to limit your jaw opening and interfere with your ability to eat?' was 21.1%, while the percentage of those who did not answer was 78.9%. The proportion of those who said 'no' to the question of 'In the last 30 days, did your jaw lock so you could not open all the way, even for a moment, and then unlock so you could open all the way?' was 21.1%, and 78.9% for those who did not answer. The rate of those who answered 'no' to the question which was 'Is your jaw currently locked or limited so that your jaw will not open all the way?' was 15.8%, while the rate of those who did not answer was 84.2%. The ratio of those who stated that in the last 30 days, when the mouth was wide opened, the jaw locked or caugt even for a moment not closed from this wide opening position was 5.3%. In terms of the parameters of temporal headache, it was stated by patients who complained of this symptom that the headache began on average 12 months ago, with the longest period of being 24 months, and the shortest 7 months.

When the TMJ noises during open and close movements were examined, the right TMJ examiner open click rate was 15.8%, the right TMJ examiner close click rate was 5.3%, the right TMJ patient click rate was 5.3%, the left TMJ examiner open click rate was 15.8%, and the left TMJ examiner close click rate was 15.3%. When the TMJ noises during lateral and the protrusive movements were examined, the right TMJ examiner click rate was 10.5%, and the left TMJ examiner click rate TME was 5.3%. In terms of joint locking, it was determined as 5.3% when the left TMJ was opening by examiner.

When looking at the muscles and TMJ pain with palpation, it was seen on the right side, middle of temporalis muscle had 10.5% pain ratio, while pain in the body of masseter was 68.4%, and lateral pole of TMJ had 52.6%. For the left side, body of masseter had the pain ratio as 57.9%, and lateral pole of TMJ was 47.4%. For the supplemental muscle group examination, left submandibular region showed pain ratio as 5.3%. Additionally, right and left upper trapezius muscles showed 78.9% pain ratio. The pain ratio of SCM was 31.6%, and same for both sides like trapezius.

The percentage of the patients with muscle pain in the study included 94.7% with TMJ disorder incidance of 5.3% on the right side, and 10.5% on the left side. The type of TMJ disorder seen in the patients was disc displacement with reduction which belongs to the group of 'intra-articular joint disorders'. A statistically significant difference was found regarding muscular TMD between genders ($p=0.02$). The ratio of the muscular TMD was 95.2% in females, while 68.2% in males. When the location of the pain was examined, the masseter ranked first in both sides with the ratio 31.6% for right, and 26.3% for

left. The percentage of those who localized headache region as "temporalis " was 36.8%. 15.8% of the examined patients had right side deviation of midline, and this value was found to be 2 mm on average. The rate of patients who had a straight opening pattern was found to be 94.7%, while the rate of right-deviated patients was 5.3%.

In addition to the form used in this study, PPT values of the muscles which gave reactions to the palpation tests were found as follows: PPT values for the right side; 1.108±0.166 kgf/cm^2 for the masseter, 1.020±0.268 kgf/cm^2 for upper trapezius muscle, and 0.800±0.245 kgf/cm^2 for SCM, and for the left side; 1.164±0.246 kgf/cm^2 masseter, 1.020±0.166 kgf/cm^2 for upper trapezius muscle, and 0.833±0.207 kgf/cm^2 for SCM. The PPT values on the lateral pole of TMJ were 1.080±0.235 kgf/cm^2 for the right side, and 1.111±0.136 kgf/cm^2 for the left side. There was no significant difference between right and left sides in terms of PPT values (p>0.05) (Table 2). When mandibular opening values were examined, maximum unassisted opening value were 44.430 mm in females and 47.410 mm in males, and there was a statistically significant difference between them (p=0.041). However, there was no significant difference between the pain-free opening values of patients according to genders (p = 0.081) (Table 3).

Other descriptive statistics for test measurements are shown in Table 4.

Discussion

This study was performed to get a deeper insight into the effect of body posture to TMD in subjects with IS, so as to contribute to the scarce amount of data about this topic. According to the results, there was statistically significant relati-

Table 2 - PPT (Pressure Pain Threshold) values of the anatomical structures that have been assessed with algometer (±SD: Standard Deviation).

	RIGHT SIDE (kgf/cm^2)				LEFT SIDE (kgf/cm^2)				
Anatomical Structure	**Minimum**	**Maximum**	**Mean**	**±SD**	**Minimum**	**Maximum**	**Mean**	**±SD**	**p**
Masseter	0.700	1.300	1.108	0.166	0.600	1.500	1.164	0.246	0.258
Upper trapezius	0.600	1.500	1.020	0.268	0.800	1.300	1.020	0.166	0.899
SCM†	0.500	1.000	0.800	0.245	0.500	1.000	0.833	0.207	0.235
Location of pain	0.500	1.200	0.963	0.200	1.000	1.200	1.057	0.098	0.220
TMJ‡	0.700	1.500	1.080	0.235	0.800	1.200	1.111	0.136	0.679

SCM†: sternocleidomastoid muscle
TMJ‡: temporomandibular joint
P value <.05 was considered as significant

Table 3 - Mandibular opening values according to genders.

Test parameter	**Female**	**Male**	**p**
Pain free opening	43.520 ± 4.833	46.180 ± 4.905	0.081
Maximum unassisted opening	44.430 ± 4.600	47.410 ± 4.646	**0.041**

P value <.05 was considered as significant

Table 4 - Descriptive statistics of measurement values of the study (±SD: Standard Deviation).

Test parameter	Minimum(mm)	Maximum(mm)	Mean(mm)	±SD(mm)
Pain free opening	32.000	52.000	43.158	4.413
Maximum unassisted opening	34.000	52.000	43.632	4.153
Right lateral movement	2.000	8.000	5.895	1.524
Left lateral movement	3.000	8.000	5789	1.398
Protrusion	4.000	7.000	4.684	1.003
Overjet (reference tooth)	1.000	5.000	2.763	1.337
Overbite (reference tooth)	0.000	5.000	3.263	1.368

onship between TMD and IS in this study, thereby leading to a rejection of the null hypothesis. In the literature, a variety of results have been reported about posture-TMD correlation. Some studies found a relation between posture and TMD (20, 21), while the others did not state any kind of relation (16, 22). In this respect, some researchers support the theory that in case of the forward-inclined head position, the dislocated center of gravitation could be a risk factor in the development of TMD; others report that a laterally inclined head position assists the mandible deviation loading the joint asymmetrically (23, 24). The same variational situation is also present in the reports when it comes to children from the point of view of postural changes (25). That's why pediatric patients with IS were chosen to perform this study, as this group of patients have precise postural changes on frontal plane.

The data obtained in the study show that patients with IS are more likely to have muscular disorders than any other TMD. From this point, the involvement of muscles seems to be a discriminant factor in terms of TMD. This situation supports the hypothesis of Deriu et al. (2010) that the presence of oligo and polysynaptic pathways between the vestibular labyrinth and the masticatory muscles (called vestibulo-masseteric reflex) can be taken into account for a possible relationship between postural disorders and myogenous disorders though arthrogenous ones (26). However, this hypothesis remains speculative at this stage and could not be proven yet.

It was found that there were postural changes compared to Cobb angle values measured in the test group. Postural change is not within the scope of the present study, and it can be assumed among the limitations of it. In the literature, the higher rate of changes in the cervical, head and shoulders area is concerned with the adaptation of masticatory muscles (27). Additionally, Chaves et al. (2014) reported that the postural changes observed on the head and shoulders has a relationship with the biomechanical adaptation of the masticatory muscles and following alterations in the TMJ, thus these changes may create future problems in these patients (13). In this respect, obtained results in the present study are consistent with the mentioned study, and have opposite conclusions with the study of Rocha et al. (2017) (16). This is an incomplete topic that there is still not enough study to uncover the correlation between posture and TMD.

According to the results of the present study, it was found that female patients showed more muscular TMD incidance than male patients (Female: 95.2%, Male: 68.2%). This situation is consistent with other studies in the literature, and in addition to hormonal factors, parafunctional habits in females are more frequent, so it is effective in increasing the frequency of muscular TMD being more susceptible to musculoskeletal pain than males even in early puberty (28). This result on TMD should be confirmed with studies performed with involvement of hormone levels,

evaluation of stress or any other possible related factors mentioned above.
The presence of temporal headache, obtained PPT values for evaluated muscles, and limited number of findings of TMJ (joint noises, locking or catching) indicate signs of parafunctional activity in the study patients. These findings may be due to emotional stress, pubertal period or the presence of IS. As, some of the patients in the study are in the pubertal period and have mixed dentition. According to Sonmez et al. (2001), the prevalence of TMD symptoms was found to be statistically significantly higher at the time of mixed dentition (68%) than that of the permanent dentition (58%) (29). However, this does not mean that other TMD types is not seen in these group of patients. As, disc displacement with reduction were detected with the ratio of 5.3% on the right side, and 10.5% on the left side in the patients. Thus, further studies are needed to reveal main causes and the related factors of this situation.
In the literature, the differences in results between studies about this topic could be attributed to the factors related to the methodology, sample size, method of postural evaluation (by means of photograph, radiograph or posturograms), and individual variables (14). Therefore, it would be better to use more accurate ways to evaluate patients and avoid bias results, and take into account the specific condition of each subject (30). In this respect, the methodology used in previous studies was followed in the present study.
In summary, postural changes in adolescents may be concerned with the extrinsic and intrinsic factors of the patient (31). Studies indicate that there are ergonomic, genetic and lifestyle factors that may initiate these alterations (32). With this regard, it becomes obligatory to improve rehabilitation and orientation programs for above mentioned adolescents and children with the aim of hindering possible future complications about TMD. Additionally, further research comparing different postural alterations and etiological roles of spinal deformities by using higher samples to allow extrapolation of results is required to enhance the scientific knowledge about this subject.

Conclusions

Within the limitations of the study, it may be concluded that relationship can be found between craniocervical posture in the frontal plane and the presence of temporomandibular disorder in IS patients. An original finding of the current study was the presence of alterations in the spine is a risk factor for pain disorders of TMD. Therefore, patients with IS should be routinely controlled in terms of TMD and necessary measures should be taken early to reduce the need for further treatment options.

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