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Relationship between temporomandibular joint dysfunction and cervical inclination and craniocervical posture in class II division 1 malocclusion

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Abstract

Introduction This study aimed to evaluate the relationship of Temporomandibular joint dysfunction (TMD) and different types of cervical spine inclination and craniocervical posture in a sample of Class II Division 1 malocclusion among adult Pakistani population.

Materials and Methods: Clinical examination of the joint with associated structures was performed to evaluate the Temporomandibular joint (TMJ) status. Lateral cephalograms carried out in natural head position were traced to classify the malocclusion through angles and evaluation of cervical inclination through two angles (OPT/HOR and CVT/HOR). Craniocervical posture was evaluated through two angles (NSL/OPT and NSL/CVT).

Results: Results of the study show that out of 70 adult Class II division 1 patients 65.7% had no TMD, 15.7% had moderate TMD and only 7.14% had severe TMD. Though TMD was found in all three types of craniocervical postures but the highest prevalence of TMD was found in the patients with extended craniocervical posture i.e., 55% with respect to angle NSL/CVT and 45% with respect to NSL/OPT. As per cervical inclination the prevalence of both moderate and severe TMD was highest in forward neck posture group. Moderate TMD was present in 45.5% - 72.7 % of the sample and severe TMD was present in 60% of forward neck posture group.

TMD was weakly but significantly correlated with craniocervical posture ($r = 0.292$, $p = 0.014$). There was no significant relationship of TMD with cervical inclination variables.

Conclusion: Results of this study conclude that high prevalence of TMD in the sample population with extended craniocervical posture and forward neck inclination. A weak correlation existed between the craniocervical posture and TMD. Extended craniocervical posture in the patients with skeletal and dental Class II Division 1 patients seems to be a risk factor for development of articular and functional problems.

Keywords: Class II division 1, craniocervical posture, malocclusion, temporomandibular dysfunction

Introduction

TMJ is a bilateral synovial joint that permits movement of the mandible in three planes of space and serves in speech, mastication, and deglutition.[1]

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TMD involves the Temporomandibular joint, the masticatory muscles and the teeth.[2] TMD was defined as a group of orofacial disorders characterized by pain in the pre-auricular area, TMJ, or muscles of mastication, limitations and deviations in mandibular range of motion, and TMJ sounds during jaw function by the American Dental Association President's Conference on Temporomandibular Disorders.[3]

The etiology of this disorder is multifactorial and ranges from individual risk factors like age, gender, hormone imbalance and occlusion to stress adaptability. The role of

occlusion has low etiological reference now and the literature has consensus on it.[4] Recent studies suggest that certain skeletal and facial morphologies do have an etiological role in TMD through their associated dental manifestations and muscular factors.[5] This role is suggested to arise from imbalance between the forces exerted during function and parafunction and the load-ability of the joint.[6]

The area that includes the occiput, atlas, and axis, as well as ligaments and other related structures, is known as the craniocervical junction. They are designed specifically to enable a variety of head motions, including flexion, extension, lateral bending, and lateral rotation.[7] Craniocervical posture is alignment of head in relation to neck. Craniofacial structure and cervical spine are adjacent structures acting in synergy with each other to provide complex stomatognathic functions. These are anatomically, functionally related and mutually influenced. Schwartz suggested a relationship between head position and dentofacial morphology.[8]

When the head tilts back on cervical spine it is considered extended and when it tilts downwards anteriorly it is called flexed head posture. In literature extended head posture was shown to be related to Class II malocclusion, crowding of teeth, Overjet, Overbite, Dental proclination, and increased lower facial height.[9] The mechanism of this is still unclear.

A study was conducted by Sonnesen relating craniofacial morphology to temporomandibular dysfunction. A collection of temporomandibular indications and symptoms were shown to be significantly correlated with both craniocervical (NSL/OPT) and cervico-horizontal factors (OPT/HOR, CVT/HOR). Although it was shown that TMD symptoms and signs, such as clicking and decreased mobility, were linked to an increased craniocervical angulation, no definitive conclusions could be drawn about any specific craniofacial morphology in children with TMJ dysfunction symptoms and signs.[10]

A recent systematic review and meta-analysis exhibited a statistically significant correlation of TMD with posture and that occlusal appliance therapy to alleviate symptoms of TMD had positive effects on craniocervical posture as well.[11] However; other authors have claimed that individuals with TMD present no more abnormalities in these segments than individuals without TMD.[12]

There are several hypotheses explaining the relationship between cervical column dysfunction and TMD. Forward head position is usually associated with neck pain as a result of posterior cervical muscular stress in an attempt to maintain head equilibrium over the spine.[13] The posture is also linked to TMD because it changes the position of the mandibular condyle and overloads the TMJ.[14]

TMD is a major factor in deciding for the initiation of Orthodontic therapy, and remains an important finding even during the entire duration of all types of Orthodontic and Orthognathic treatments. Dysfunction of the joint arising or aggravating during the course of treatment is a major limitation and hinders treatment completion within due time. Identifying the etiology of dysfunction is of utmost importance. A relationship between TMD and craniocervical posture in patients of Class II malocclusion will serve as a valuable information in treating this group of patients and will help take precautions, identify, prevent and even treat any TMD arising prior to or during treatment, due to CCP variation without the need of pausing or discontinuing the Orthodontic treatment. In the light of above discussion and absence of any local data addressing this topic this research was designed to evaluate the relationship of Temporomandibular joint dysfunction (TMD) and different types of cervical spine inclination and craniocervical posture in a sample of Class II Division 1 malocclusion.

Materials and Methods

The study was approved by Institutional Review Board of FMH College of Medicine & Dentistry. Informed consent was taken once the sample is selected. The primary outcome variables were the cervical inclination, craniocervical posture and TMD. Craniocervical variables were assessed through cephalometric analysis. Lateral cephalograms of all participants were taken in natural head position and were drawn manually. Outcome variable in terms of various types of cervical inclination and craniocervical posture i.e., flexed, normal and extended were noted as per operational definition.

A total of 70 adult skeletal Class II division 1 cases (ANB^0 > 4) with Dental Class II malocclusion (molar relation half cusp or full cusp Class II) and Overjet ≥ 5mm, were enrolled in this study. There was absence of history of previous Orthodontic treatment and any bone, muscle or joint diseases. Absence of upper respiratory disease or allergic rhinitis and deviated nasal septum were also ensured.

All participants were examined clinically for TMJ click, TMJ pain, Muscle of mastication pain, Maximum mouth opening (MMO) and mandibular deflection during opening and scored according to clinical dysfunction index of Helkimo.

Helkimo Index

Scoring system:

0= no pain in joint & muscles, click, mouth opening >40mm

1= tenderness in joint & muscles, unilateral click, mouth opening <30mm

2= definite joint pain & muscle, bilateral click, mouth opening <20mm

Scores from all 5 domains added to get total score:

0 = no dysfunction of the temporomandibular joint,

1-4 = mild dysfunction

5-8 = moderate dysfunction,

≥ 9 = severe dysfunction.

Lateral cephalograms of patients fulfilling inclusion criteria were taken in natural head posture and traced by a single researcher (Fig 1). Maxillary and mandibular skeletal bases were measured by SNA and SNB respectively and ANB angle and Overjet was taken to classify skeletal malocclusion.

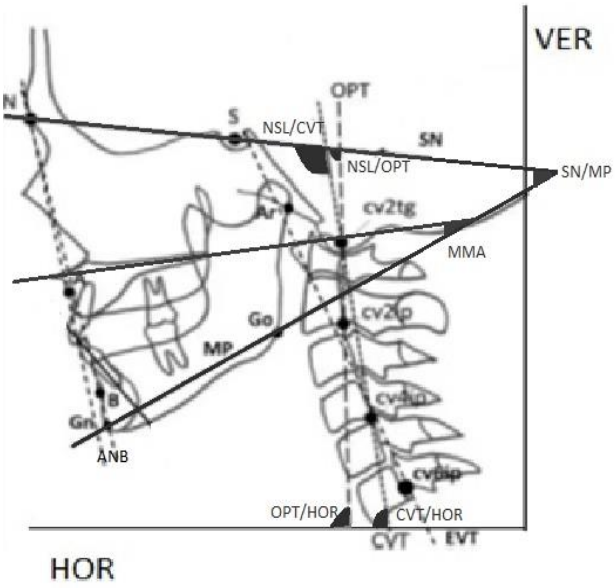

Figure 1: cephalometric landmarks and planes

NSL Nasion-Sella plane: Line through Nasion and Sella points

SNA angle: Angular relationship of maxilla to cranial base.

SNB angle: Angular relationship of mandible to cranial base.

ANB angle: Angular relationship of maxilla to mandible

MP: anatomical plane of mandible

PP: anatomical plane of maxilla

HOR: true horizontal plane, perpendicular to true vertical plane

OPT (Odontoid process tangent): Posterior tangent to the odontoid process. Drawn through the most posterior and inferior point on the corpus of the second cervical vertebra. Represents upper part of column

CVT (Cervical tangent): Drawn as posterior tangent to the most posterior and inferior point on the corpus of the fourth cervical vertebra. Represents mid part of cervical column

Angles that describe the vertical skeletal pattern:

SN/MP: angle formed b/w NSL and MP.

MMA: angle formed b/w PP and MP

Angle that describes the cranial posture with upper part of cervical spine:

NSL/OPT; Angle formed between NSL and OPT

Angle that describes the cranial posture with middle part of cervical spine:

NSL/CVT; Angle formed between NSL and CVT

Angles that describe neck position

OPT/HOR: Angle between OPT and true horizontal plane

CVT/HOR: Angle between CVT and true horizontal plane

Two angles NSL/OPT and NSL/CVT were recorded to define craniocervical posture. Normal range of angle NSL/OPT is 89-105 degrees. Normal range of angle NSL/CVT is 96-112 degrees.

Normal Craniocervical posture is when the value of angle NSL/OPT is within the range of 89-105 degrees. And angle NSL/CVT is within the range of 96-112 degrees.

Extended Craniocervical posture is when the angle NSL/OPT is >105 degrees and angle NSL/CVT is >112 degrees.

Flexed Craniocervical posture is when the value of angle NSL/OPT is <89 degrees and angle NSL/CVT is <96 degrees.

Cervical inclination was measured by two angles i.e., OPT/HOR (93±5) and CVT/HOR (86±4). It is labelled as forward neck inclination if the angle OPT/HOR is $<88^0$ and the angle CVT/HOR is $<82^0$. Forward neck posture with extended craniocervical inclination is called forward head posture

Results

A total of 70 Class II Division 1 cases were enrolled in this study. Data obtained was mainly organized into tables.

The mean age of the patients was 21.5±1.9 years with a range of 19 & 26 years respectively. Out of the sample 43 (61%) were females and 27 (39%) were males.

Frequency distribution of molar relation showed that there were 38.6% patients were of class 2 and 61.4% patients were end on class II.

The results of descriptive statistical analysis of this cross-sectional study are shown in table 1. Craniocervical posture was determined by two angles, namely NSL/CVT and NSL/OPT. The mean NSL/OPT of the patients was 104.2±8.6 degrees with a range of 83-121 degrees. Mean NSL/CVT of the patients was 108.3±7.4 with a range of 89-127 degrees. Cervical inclination was measured by two angles i.e., OPT/HOR (93±5) and CVT/HOR (86±4).

With regards to angle made between the mid-section of cervical spine and cranial base i.e., NSL/CVT Craniocervical posture was found to be Extended in 20(28.6%) of the sample, Flexed in 3(4.3%) and Normal in a majority of 47(67.1%).

As per angle formed between the upper section of the cervical spine and cranial base i.e., NSL/OPT Craniocervical posture was Extended in 33(47.1%), Flexed in 2(2.9%) and Normal in 35(50%) of the subjects. (**Table# 1)**

Table I: Descriptive statistics of Craniocervical posture though angle NSL/CVT

	Frequency	Percentage	Cumulative Percent
Flexed	3	4.3	4.3
Normal	47	67.1	71.4
Extended	20	28.6	100.0
Total	70	100.0	
Descriptive statistics of Craniocervical posture through angle NSL/OPT			
Flexed	1	1.4	1.4
Normal	36	51.4	52.9
Extended	33	47.1	100.0
Total	70	100.0	
Descriptive statistics of cervical inclination as per angle OPT/HOR			
Forward	17	24.3	24.3
Normal	24	34.3	58.6
Backward	29	41.4	100.0
Total	70	100.0	
Descriptive statistics of cervical inclination as per angle CVT/HOR			
Forward	31	44.3	44.3
Normal	24	34.3	78.6
Backward	15	21.4	100.0
Total	70	100.0	

The cervical inclination and position were forward in 24.3 % of the sample as per angle OPT/HOR and in 44.3% of population as per angle CVT/HOR. (Table I)

The frequency distribution of TMD of the patients showed that there were 46(65.71%) patients in which TMD was not found, 8(11.43%) appeared with mild TMD, 11(15.71%) patients appeared with moderate TMD and only 5(7.14%) patients appeared with severe TMD.

TMD, in the form of moderate to severe dysfunction was more prevalent in the forward cervical inclination group than normal and backward cervical inclinations. As per angle of the upper part of cervical column with true horizontal (OPT/HOR) moderate TMD was found to be in 24.3% of the sample, 60% of which had severe TMD signs and symptoms.

With respect to angle of the middle section of cervical column with true horizontal (CVT/HOR), TMD was found to be in highest prevalence of 44.3%, of which 72.7% were of moderate category and 60% were in severe TMD category. (Table II)

Table II: Descriptive statistics of TMD in various cervical and craniocervical posture categories

			TMD				
			No	Yes (Mild)	Yes (Mod)	Yes (Severe)	Total
OPT/HOR	Forward	Count	8	1	5	3	17
		% Within TMD	17.4%	12.5%	45.5%	60.0%	24.3%
	Normal	Count	17	3	4	0	24
		% Within TMD	37.0%	37.5%	36.4%	0.0%	34.3%
	Backward	Count	21	4	2	2	29
		% Within TMD	45.7%	50.0%	18.2%	40.0%	41.4%
CVT/HOR	Forward	Count	18	2	8	3	31
		% Within TMD	39.1%	25.0%	72.7%	60.0%	44.3%
	Normal	Count	17	4	2	1	24
		% Within TMD	37.0%	50.0%	18.2%	20.0%	34.3%
	Backward	Count	11	2	1	1	15
		% Within TMD	23.9%	25.0%	9.1%	20.0%	21.4%
NSL/CVT	Flexed	Count	2	0	1	0	3
		% Within NSL/CVT	66.7%	0.0%	33.3%	0.0%	4.28%
	Normal	Count	35	6	4	2	47
		% Within NSL/CVT	74.5%	12.8%	8.5%	4.3%	67.14%
	Extended	Count	9	2	6	3	20
		% Within NSL/CVT	45.0%	10.0%	30.0%	15.0%	28.57%
NSL/OPT	Flexed	Count	10	0	1	1	12
		% Within NSL/OPT	83.3%	0.0%	8.3%	8.3%	17.14%
	Normal	Count	31	7	4	2	44
		% Within NSL/OPT	70.5%	15.9%	9.1%	4.5%	62.85%
	Extended	Count	5	1	6	2	14
		% Within NSL/OPT	35.7%	7.1%	42.9%	14.3%	20%

The flexion or extension of head as defined by two angles, NSL/CVT and NSL/OPT also affected the prevalence of TMD. Joint signs and symptoms were more prevalent in the extended craniocervical group. According to angle NSL/CVT, 30% of population showing extended CCP had moderate TMD and 15% had severe TMD. As per angle NSL/OPT, 42.9% of sample labeled as extended CCP had moderate TMD and 14.3% had severe TMD. (Table II)

When correlation coefficient of TMD categories was calculated, TMD was weakly but significantly correlated with craniocervical posture ($r = 0.292$, $p = 0.014$). There was no significant relationship of TMD with cervical inclination variables.

Discussion

The term "temporomandibular disorder" (TMD) refers to a variety of clinical issues that affect the masticatory muscles, the TMJs and its related structures, or both. TMD is of two origins i.e., myogenic (related to the muscles of mastication) and atherogenic (related to the joint and associated bony structures). It is the most common clinical condition affecting the masticatory apparatus and the leading source of non-dental pain in the oral or face region.[1-3]

The prevalence of TMD ranges from 50%-75% in general population. And objective signs of TMD was more prevalent in females (61.4%) than in males (56.96%).[15]

The presence and severity of TMD is assessed in a number of ways. Helkimo was a forerunner in the development of indices to assess the severity of TMJ issues and discomfort in this system. He created an index in epidemiological research that was subsequently subdivided into anamnesis, clinical, and occlusal dysfunction. Clinical Dysfunction index, comprises a functional evaluation of the masticatory system i.e., range of mandibular motion, muscle tenderness, TMJ pain during palpation, pain during mandibular movement.[16] Clinical part of the index was used in this study to screen for TMD.

There is small number of studies which have demonstrated the association between head posture and anteroposterior skeletal patterns. In the current study, the relationship between cervical and craniocervical inclination was recorded with TMD in a sample of Class II Division 1 sample. The frequency of various types of Craniocervical posture in Class II Division 1 and prevalence of TMD in the sample group were recorded.

According to this study in Class II division 1 was 51.4 -67.1% of sample had normal craniocervical posture. The next most prevalent type of head posture was Extended (posterior head rotation) i.e., 28.6-47.1%; whereas Flexed type of head posture (anterior head rotation) was seen in only 1.4-4.3% of the Class II division 1 sample according to the two angles NSL/OPT and NSL/CVT.

Another Study related extended craniocervical posture to Class II malocclusion, crowding, increased lower facial height and bimax dentoalveolar proclination.[17]

In this study the cervical inclination was forward in 24-44 % of the sample. This in turn needs the head to be tilted backwards upon cervical spine to maintain a straight line of sight. These results agree with a recent study reporting that posteroinferior angle of the cervical spine decreased in Class II subjects showing forward neck inclination.[18]

Results of this study were found in contradiction with study of Tauheed S *et al.* who reported no association between cervical inclination and skeletal malocclusion but found a weak and significant correlation of cervical curvature with the skeletal Class of the patients.[19]

The frequency distribution of TMD of the patients showed that TMD, in the form of moderate to severe dysfunction was more prevalent in the forward cervical inclination group than normal and backward cervical inclinations.

As per angle of the upper part of cervical column with true horizontal (OPT/HOR) moderate TMD was found to be in 24.3% of the sample, 60% of which had severe TMD signs and symptoms. With respect to angle of the middle section of cervical column with true horizontal (CVT/HOR), TMD was found to be in highest prevalence of 44.3%, of which 72.7% were of moderate category and 60% were in severe TMD category.

The cervical spine clearly refers pain to the head and orofacial areas, according to the literature. This relation is due to intricate neurophysiological, biomechanical, and functional connection between the two. TMD with cervical spine comorbidity is highly prevalent and includes functional limitations, discomfort, sensitive spots, and hyperalgesia of the neck and shoulder area. A study reported clinically relevant association

between cervical disability in TMD patients. These patients showed reduced pressure pain thresholds and loss of cervical muscle endurance.[20]

As per craniocervical posture, TMD was found in all three categories but the highest prevalence of TMD was found in the patients with extended craniocervical posture i.e., 55% with respect to angle NSL/CVT and 45% with respect to NSL/OPT. Mild TMD was prevalent in both normal and extended head posture but moderate TMD (30-42.9%) and severe TMD (14-15%) were more prevalent in extended craniocervical posture.

These findings agree with Tatu E. who assessed craniocervical posture in patients with diagnosed TMD and reported that significant dorsiflexion (extension) of cranium over cervical vertebrae was present in such patients.[20] These findings do not agree with Omer ekici who stated that there is no relationship between TMD and craniocervical posture and TMD is related to hyoid bone position and craniofacial form.[21]

Despite the high prevalence of TMD in both forward cervical inclination and extended craniocervical posture the correlation was not strong or significant. This does not agree with a recent meta-analysis that suggested that there is statistically significant correlation between TMD and craniocervical posture and that bite appliance or splint therapy affects both TMD and craniocervical posture.[22]

In the light of the findings of this study, extended craniocervical posture is related to moderate and severe forms of TMD more frequently in Class II division 1 patients. Postural evaluation should be carried out in all such patients along with functional evaluation of the TMJs.

If any postural abnormality is found with or without presence of TMD, special precautions should be taken in treatment planning and mechanotherapy. Patient should be kept informed and reassured and physiotherapy for craniocervical posture correction can be added to the plan.

Conclusion

In the light of this study, it can be concluded that moderate and severe TMD was found to be more prevalent in forward neck inclination and extended craniocevical posture.

The correlation of TMD was weak positive but significant with craniocervical posture but was insignificant with cervical inclination.

Conflict of interest

No conflict of interest.

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