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The Morphology of the Temporomandibular Joint in Subjects with Anterior Overbite and Overjet and Its Association with TMJ Dysfunction - A Clinical, Tomographic and MRI Study

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ABSTRACT

The purpose of the study was to correlate morphological changes in temporomandibular joint structures and symptoms of temporomandibular disorders in patients with increased overjet and overbite.40 subjects with increased overjet or overbite and 20 with normal overjet and overbite were selected for the study. After clinical examination of TMJ, overjet and overbite were measured on maxillary and mandibular casts with the help of ruler and pencil and the measurements were further subdivided into 3 groups. To assess the morphology of the TMJ conventional tomogram were performed in all subjects and MRI was performed for subjects who were having symptoms of TMD. The data was statistically analyzed. There were only 4 subjects who were symptomatic for TMJD with increased overjet and overbite out of the total 40 subjects in the study group. Also, the symptomatic subjects were found only in the increased (3-6mm) overbite group. Anterior joint space was the only morphological parameter of TMJ that was significantly associated with increased overjet and overbite. However, all other parameters like the Posterior joint space, Superior joint space, height of the articular fossa as well as the percentage of the joint spaces were statistically insignificant when the control group was compared to subjects having increased overjet or overbite. From the present study, it can be stated that overjet and overbite does not play any role in the etiology of TMJD. Increased values of overjet and overbite are compatible with normal functioning of the TMJ.

Keywords
Temporomandibular joint, Overjet, Overbite, Magnetic Resonance Imaging

Introduction

Temporomandibular joint disorders (TMJD) have heterogeneous etiological factors and malocclusion is one of them. Amongst the adult population, about 20% to 30% are affected to some degree.[1] TMJD are a major source of orofacial pain of non-dental origin and are considered to be a sub classification of musculoskeletal disorders.[2] Other conditions, such as parafunctional habits, emotional stress, trauma, sleep disorders, postural abnormalities, systemic factors are also present with particular frequency in patients with TMJD signs. Recognition and differentiation of TMJD is not very clear to the professional because of the etiological complexity involved and variety of signs and symptoms that may also represent other pathologies.[3]

Though it is very important to clarify the relationship between the dentofacial structure and the TMJ structure, few studies of this kind have been reported. The question of whether or not the occurrence of malocclusion traits are related to symptoms and signs of TMJD has attracted considerable interest.[4] Angle in 1918 first stated the predisposing position

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for malrelationship of the mandibular condyle and temporal fossa with respect to TMJ problems .[5] Despite decades of clinical experience and debate, there is persistent confusion about the relationship of occlusion to the identification and treatment of TMJD. The condyle moves correspondingly with respect to mandibular movements in the glenoid fossa. It is presumed that there should be a greater condylar movement in patients having increased anterior overbite and overjet as compared to patients having normal anterior teeth relation.[6] Also, it is suggested that the nature of stress distributions in the TMJ is affected by vertical discrepancies of the craniofacial skeleton. This causes disturbance of the biomechanical equilibrium of the TMJ leading to TMJD.[7] There may be a U-shaped relationship between overjet or overbite and TMJD, which implies that large negative as well as positive values may be related to TMJD in comparison with a middle range.[8] Such knowledge might assist in the establishment of biological treatment strategies, especially when the TMJ is the target of the treatment plan.[9]

Reliable case history and the patient's clinical examination are usually insufficient to base exact diagnosis of TMJD.[10] The correlation between the images and clinical findings has led to a better understanding of the pathophysiology of TMJD. Basic X–ray examination like plain film radiography and tomography are the most readily available method of imaging which usually has no contraindications. Magnetic Resonance Imaging (MRI) is currently considered as the gold standard for the examination of TMJ disc displacement.[11]

This study aims to evaluate the morphology of the temporomandibular joint in subjects with anterior overbite and overjet and its association with TMJ dysfunction.

Methods

A hospital based case control study was carried out in the Department of Oral Medicine and Radiology and Department of General Radiology, to assess the morphology of the TMJ in subjects with increased overbite or overjet. The study comprised of 60 subjects which were divided into 2 groups, group I: control group: consisted of 20 subjects with normal anterior teeth relationship and group II: study group: consisted of 40 subjects with increased anterior overjet and / or overbite.

The inclusion criteria for the study included, subjects having all the first and second molars present in all the four quadrant and subjects having increased anterior overjet and / or overbite and symptomatic for TMJD.

The exclusion criteria for the study included, subjects with severe attrition, history of facial injury or facial bone fracture, limitation in mouth opening due to any cause, history of parafunctional habits like bruxism, history of orthodontic treatment, patients with previously diagnosed TMJD and having normal anterior teeth relationship.

Subjects were apprised of the purpose of the study and written consent was taken prior to commencement of the study. Ethical clearance was obtained from the ethics committee of the institution.

Methodology

The demographic data for all the patients was recorded in a predesigned proforma. After thorough intraoral examination, clinical examination of TMJ was performed for each subject.So as to measure the increased anterior overjet and / or overbite accurately, casts were made for maxillary and mandibular arches. Measurement of overjet and overbite was done with the help of a pencil and ruler. Overbite was measured as the vertical overlap of the maxillary and mandibular permanent central incisors. While overjet was measured as the linear distance in millimetres from the facial surface of the mandibular permanent incisors to the incisal edge of the most protrusive maxillary permanent central incisor.The sample was further subdivided into 3 groups depending upon the overjet / overbite measurements (Normal : 1-3 mm overjet and overbite, Increased : 3-6 mm overjet and / or overbite, Excessive : > 6 mm of overjet and / or overbite). To assess the morphology of the TMJ conventional tomogram were performed with the help of Conventional Digital Tomographic machine (Kodak 8000 C Digital Panoramic and Cephalometric System) in centric occlusion for all the subjects with the following parameters: 75 kVp, 12 mA, 4.6 seconds.

The landmarks used for measurements on the conventional tomogram are illustrated and are constructed in the

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following manner with the help of Kodak Digital Imaging Software version 6.12.32.0. (Figure 1)

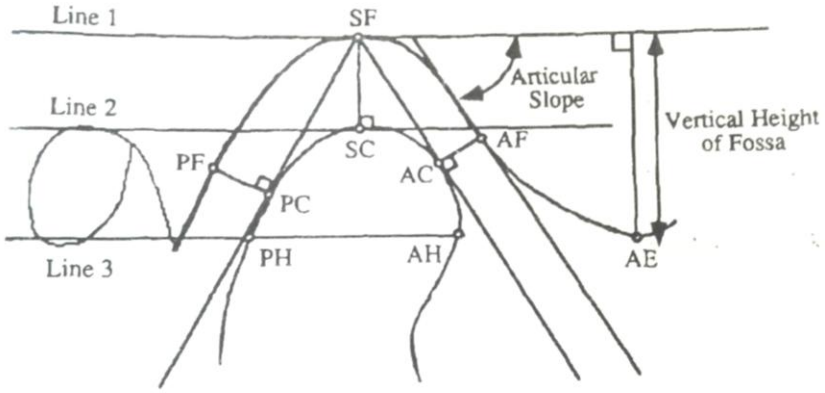

Figure 1- Construction of landmarks used in the analysis of conventional tomogram

SF was the most superior point of the glenoid fossa, SC was the superior most point of the condyle, AC as anterior condyle point, PC as posterior condyle point, AF as perpendicular drawn from point AC at anterior part of glenoid fossa, PF as perpendicular drawn from point PC at posterior part of glenoid fossa, AH as the point of intersection of line 3 at anterior aspect of the condyle, PH as the point of intersection of line 3 at posterior aspect of the condyle and AE as the point at the most inferior aspect of the crest of the articular eminence.

Line 1: was drawn tangent to the most superior point of the glenoid fossa (SF) and parallel to the superior border of the radiographic film. Line 2: was drawn parallel to line 1 to locate the superior aspect of the condyle (SC). Tangents were then drawn from SF point tangent to the anterior and posterior aspects of the condylar head at the anterior condyle point (AC) and posterior condyle point (PC), respectively. Perpendiculars to these tangents from AC and PC points intersected the glenoid fossa at points anterior fossa (AF) and posterior fossa (PF), respectively. A line was then drawn through AF point tangent and best fit to the anterior slope of the glenoid fossa and called articular slope (AS). Line 3: was drawn parallel to line 2 through the most convex point on the anterior aspect of the condylar head.The intersections of line 3 with anterior and posterior aspects of the condyle were referred to as anterior head of the condyle (AH) and posterior head of condyle (PH), respectively. The most inferior aspect of the crest of the articular eminence was located at point AE.

The following measurements were made from corrected tomograms individually for right and left joints of each subject, anterior joint space as the distance between points AC and AF.

Posterior joint space as the distance between points PC and PF and percentage of posterior to anterior joint space, expressed as:

$$\frac{\text{Posterior joint space} - \text{anterior joint space}}{\text{Posterior joint space} + \text{anterior joint space}} \times 100\%$$

MRI was performed for subjects with increased overjet and / or overbite who were having symptoms of TMJD. A 1.5 T GE HD 16 channel MRI scanner was used to acquire bilateral sagittal oblique and coronal oblique images. The sagittal MRI central sections of the TMJ were selected for measurement in the closed position whereas the central section was determined as the section where the greatest portion of the mandibular ramus could be recognized. To describe joint morphology, MRI scans were evaluated with four linear measurements and one ratio. (Figure 2)

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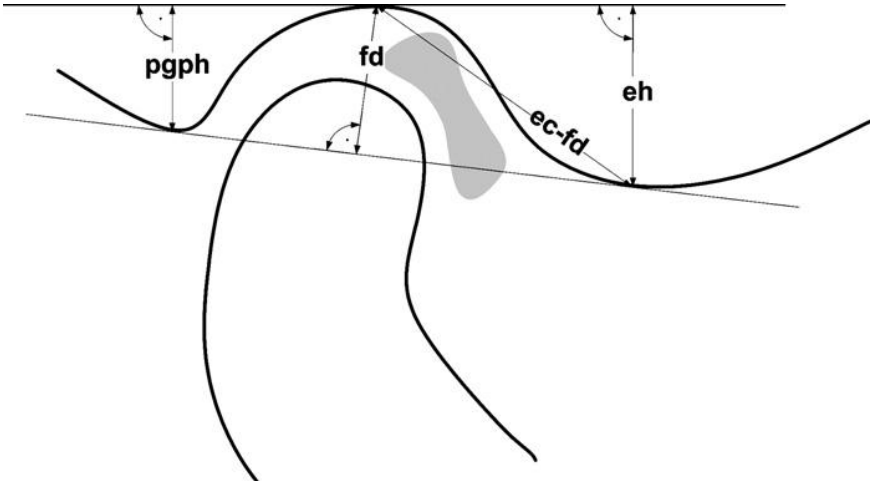

Figure 2- Construction of landmarks used in the analysis of MRI

A parallel line to the Frankfurt plane and a tangent drawn between the most inferior points of the eminence and postglenoid tubercle were used as reference lines.The measurements were defined for right and left sides of each symptomatic patients as follows: Eminence height (eh) was the distance between crest and a line drawn as horizontal tangent to the highest point of the fossa. Postglenoid process height (pgph) was the distance between the deepest point of the postglenoid process and a line drawn as horizontal tangent to the highest point of the fossa. Fossa depth (fd) was the distance between highest point of the fossa and a point at which a connecting line met fossa width tangent at right angle. The distance between eminence crest and the highest point of the fossa was recorded (ec-fd). The eminence height / postglenoid process height ratio (eh/pgph) was also recorded.

Data Analysis

The data on demographic variables, AJS, PJS, SJS, height of articular fossa, ratio of joint spaces and percentage of joint spaces for subjects in Study and Control groups were obtained and analyzed. The age variable was categorized and expressed in terms of numbers and percentages. The descriptive parameters like mean, standard deviation, minimum and maximum were obtained for each of the above parameters on left and right joints for subjects in Study and Control groups. The statistical significance of difference in the means of each parameter between Study and Control groups was evaluated using *t-test for independent samples*, while the difference between left and right joints of each parameter was analyzed using *paired t-test.* Also, the above parameters were analyzed according to overbite and overjet categorization. The above statistical tests were used to evaluate the significance. The analysis was carried out using SPSS 18.0 (SPSS Inc.) software.

Results

There were 20 cases with overjet in normal range (1-3 mm), while 9 with increased overjet (3-6 mm) and 7 with excessive overjet (> 6 mm). There were 20 subjects with overbite in the normal range, while 22 showed increased overbite. 2 cases showed excessive overbite. The mean age of subjects in control group was 24.1 ± 1.58 years, while that in study group was 21.47 ± 4.87 years. The male to female ratio in control group was 1: 0.67 and in study group it was 1: 2.63.

Anterior joint space: Using t-test for independent samples the difference in the mean left and that of right anterior joint space of control and study groups was statistically significant with p-value of 0.0044 & 0.0341 respectively. The difference of mean left anterior joint space between normal and increased overjet, between normal and excessive group cases was significant with p-value of 0.049 & 0.028 respectively. The difference of mean right anterior joint space between normal and increased overjet cases was significant with p-value of 0.042, however, the difference between normal and excessive group was statistically insignificant with p-value of 0.168. As regards overbite, the

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difference in the mean left and that of right anterior joint space of for cases with normal overbite was statistically insignificant with p-value of 0.4919. The difference of mean left anterior joint space between normal and increased overbite groups was significant with p-value of 0.0147. The significance of difference between normal and excessive groups was not evaluated due to small sample size. Further, the difference of mean left anterior joint space between normal and increased overbite cases was significant with p-value of 0.008 while that difference for right anterior joint space was insignificant with p-value of 0.126.

Posterior joint space: The difference between the mean left and right posterior joint space of control group was statistically significant with p value of 0.0156, while for study group it was statistically insignificant with p value of 0.6278. Also, the difference in the mean for control and study groups for left posterior joint space was statistically significant p value of 0.0023 and for right posterior joint space it was statistically insignificant p value of 0.4229. Also, the difference in the mean left and right posterior joint space for cases with normal overjet was statistically significant with p-value of 0.0156, however the difference in the mean for cases with increased and excessive overjet was statistically insignificant.

Further, the difference of mean left posterior joint space between normal and increased overjet and also between normal and excessive overjet cases was statistically significant with p-value of 0.027 and 0.039 respectively. However, the difference of mean right posterior joint space between normal and increased overjet cases and also between normal and excessive groups was statistically insignificant.

Regarding overbite, the difference in the mean of left and right posterior joint space for cases with normal overbite was statistically significant with p-value of 0.0156. The difference in the mean between left and right posterior joint space for cases with increased overbite was statistically insignificant. Also, the difference of mean left posterior joint space between normal and increased overbite cases was statistically significant with p-value of 0.005. However, the difference of mean right posterior joint space between normal and increased cases was statistically insignificant.

Percentages of posterior to anterior joint spaces: The difference between the mean left and right side percentage of joint space of control group was statistically insignificant as indicated by p-value of 0.1172.However, the difference between the mean left and right side percentage of joint space of study group was statistically significant with p-value of 0.0106. Further, using t-test for independent samples the difference in the mean percentage of joint space on left side and that on right side between control and study groups was statistically insignificant with p-value of 0.3665 and 0.3807 respectively.

The difference in the mean between left and right percentage of joint spaces for cases with normal overjet, increased overjet and that of excessive overjet was statistically insignificant with p-value of 0.1172, 0.4702 and 0.3063 respectively. Further, using t-test for independent samples the difference of mean percentage of joint space on left joint and that on right joint between normal and increased overjet cases was insignificant with p-value of 0.693 and 0.370 respectively. The difference on left joint and that on right joint between normal and excessive group was statistically insignificant with p-value of 0.331 and 0.412 respectively.

As regards overbite, the difference in the means of percentage of joint space between left and right joint for cases with normal overbite was statistically insignificant with p-value of 0.1172.The similar difference in the means for cases with increased overbite was however statistically significant with p-value of 0.0078.Further, using t-test for independent samples the difference of mean percentage of joint space on left joint and that on right joint between normal and increased overbite cases was insignificant with p-value of 0.384 and 0.750 respectively.

Comparison for MRI variables for left and right joints: Using paired t-test, it was found that none of the parameters had statistically significant difference in the means of left and right joints.

NOTE: The significance of difference for excessive overbite was not evaluated due to small sample size.

Discussions

Many studies have reported that malocclusion may be relevant to inducing functional imbalance of the musculature and malposition of the condyle in the TMJ. In the literature, only few articles have reported the relationship between

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excessive horizontal and vertical overlap of the anterior teeth and TMJ dysfunction. However, there is still controversy concerning the relative importance of increased overjet and overbite in relation to other contributing factors. So, the present study was conducted to evaluate the morphology of the TMJ in subjects with anterior overbite and overjet and its association with TMJ dysfunction using conventional tomographs and MRI.

The results of the present study found that the mean age of subjects in control group was 24.1 ± 1.58 years, while that in study group was 21.47 ± 4.87 years. (Table 1).

	No. (%)		
Age (Years)	Group I: Control (*n*=20)	Group II: Study (*n*=40)	Total (*n*=60)
≤ 15	0	8 (20)	8 (13.33)
16-20	0	5 (12.5)	5 (8.33)
21-25	17 (85)	22 (55)	39 (65)
26-30	3 (15)	4 (10)	7 (11.67)
31-35	0	1 (2.5)	1 (1.67)
Mean ± SD	24.1 ± 1.58	21.47 ± 4.87	22.35 ± 4.25
Median	24.5	22.5	24
Range	(22, 27)	(13, 35)	(13, 35)

Table 1: Distribution of subjects according to age in two study groups

Also, the male to female ratio in control group was 1: 0.67, while that in study group, it was 1: 2.63. This suggested that increased overjet and overbite could be more common in females. (Table 2)

	No. (%)		
Sex	Control (*n*=20)	Study (*n*=40)	Total (*n*=60)
Male	12 (60)	11 (27.5)	23 (38)
Female	8 (40)	29 (72.5)	37 (62)

Table 2: Distribution of subjects according to sex in two study groups

In the present study, there were 20 subjects in the control group having overjet in normal range (1-3 mm), while 9 out of the 40 subjects in the study group were having increased overjet (3-6 mm) and 7 had excessive overjet (> 6 mm).Similarly, there were 20 subjects in the control group with overbite in the normal range (1-3 mm), while 22 showed increased overbite (3-6 mm) and 2 showed excessive overbite (> 6 mm) in the study group. (Table 3)

	OVERJET	OVERBITE
Normal (1- 3 mm)	20	20
Increased (3 - 6 mm)	9	22
Excessive (> 6 mm)	7	2
TOTAL	36	44

Table 3: Distribution of subjects according to overjet and overbite measurements

ANTERIOR JOINT SPACE

When statistical analysis was done to compare the AJS between the left and right joint in the control group it was found to be statistically nonsignificant. Similar comparison in the study group was found to be statistically

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significant with P value being 0.0064 (Table 4). However, the study conducted by Prabhat et al[12] has not reported any statistical significant association in both groups.

Group	Anterior joint space (mm)	N	Mean	SD	Min	Max	*P*-value			
							Control*	Study*	Left**	Right**
							Left vs Right	Left vs Right	Study vs Control	Study vs Control
Control	Left	20	1.46	0.52	0.8	2.7	0.4919	**0.0064**	**0.0044**	**0.0341**
	Right	20	1.36	0.38	0.8	2.1				
Study	Left	40	1.92	0.64	0.8	3.3				
	Right	40	1.62	0.49	0.8	2.7				

*****Obtained using *paired t-test;* ** Obtained using *t-test for independent samples*

Table 4: Descriptive statistics for left and right anterior joint space for samples in two groups

Few authors in the past have reported that some amount of the asymmetry between the right and left joints may be related to normally occurring cranial base asymmetries and side preferences during mastication.[5,6] But based on the statistical significant differences in the left and right AJS in the study group, we may be able to say that the discrepancies in both the joint spaces tend to be higher than normal, in subjects with increased overjet and overbite.

When comparing the left and right joints individually between the control and study group for AJS, statistically significant results were obtained with P value being 0.0044 and 0.0341 respectively (Table 4). Thus, based on this finding we may conclude that AJS is larger in subjects with increased overjet and overbite as compared to subjects with normal anterior teeth relationship.

On comparing the left and right joints for AJS in subjects with normal and increased overjet no statistically significant results were found for the two joints, which was in agreement with the study by Cohlmia et al.[5] But when the 9 subjects with increased overjet (3-6 mm) and 7 subjects with excessive overjet (>6mm) were compared for each joint with subjects having normal overjet, statistically significant results were obtained (P=0.049, P=0.028 and P=0.042 respectively) except for the right joint in subjects having excessive overjet. (Table 5A)

Overjet (mm)	Anterior joint space (mm)							
	Left Joint				Right Joint			
	N	Mean	SD	Median	Mean	SD	Median	*P*-value*
Normal (1-3 mm)	20	1.46	0.52	1.10	1.36	0.38	1.16	0.4919
Increased (3-6 mm)	9	1.93	0.68	1.90	1.71	0.47	1.70	0.4225
Excessive (> 6 mm)	7	2.08	0.82	1.90	1.60	0.40	1.50	0.0888
Normal vs. Increased †	**P = 0.049**				**P = 0.042**			
Normal vs. Excessive †	**P = 0.028**				P = 0.168			

Table 5A: Descriptive statistics for left and right anterior joint spaces according to overjet measurements

From the results, we might infer that with an increase in overjet an increase in AJS may be anticipated.

Out of the four comparisons between left and right joints of normal and increased overjet only one result was statistically insignificant and this could be due to an inherent asymmetry in the joints.

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When left and right joints were compared in subjects with increased overbite and normal overbite it was found that in subjects with 3-6mm overbite there was statistically significant difference (P=0.0147), but it was insignificant in the normal overbite group indicating that an increase in overbite may be responsible for asymmetry between the left and right TMJ in regards to AJS. The results in the normal overbite group was similar to those concluded by Cohlmia et al.[5]

On comparison of normal and increased overbite groups for the left and right joints, it was found that P value was significant for the left joint (P=0.008) but for the right joint it was found to be insignificant. So, again we might infer that an increase in overbite may lead to an increase in AJS. Since there were only 2 subjects with excessive overbite comparison for this parameter was not possible (Table 5B).

	Anterior joint space (mm)							
	Left Joint				Right Joint			
Overbite (mm)	N	Mean	SD	Median	Mean	SD	Median	*P*-value*
Normal (1-3 mm)	20	1.46	0.52	1.10	1.36	0.38	1.16	0.4919
Increased (3-6 mm)	22	1.93	0.57	2.00	1.59	0.55	1.50	**0.0147**
Excessive (> 6 mm)	2	2.00	0.56	1.20	1.55	0.64	1.55	-
Normal vs. Increased †	**P = 0.008**				P = 0.126			
Normal vs. Excessive †	-				-			

*****Obtained using *paired t-test;* †P-value obtained using t-test for independent samples

Table 5B: Descriptive statistics for left and right anterior joint spaces according to overbite measurements

POSTERIOR JOINT SPACE

Comparing the PJS in the control group with that of the study group the P value was found to be statistically significant for left joint (P=0.0023), whereas it was statistically insignificant for the right joint. When comparing the PJS of the control group for the left and right joints, the results were statistically significant (P=0.0156) but in the study group the results were insignificant (Table 6).

Group	Posterior joint space (mm)	N	Mean	SD	Min	Max	*P*-value			
							Control*	Study*	Left**	Right**
							Left vs Right	Left vs Right	Study vs Control	Study vs Control
Control	Left	20	2.58	0.55	1.6	3.5	**0.0156**	0.6278	**0.0023**	0.4229
	Right	20	3.02	0.83	1.1	4.2				
Study	Left	40	3.15	0.83	1.5	6.1				
	Right	40	3.22	0.99	2.1	6.9				

*****Obtained using *paired t-test;* ** Obtained using *t-test for independent samples*

Table 6: Descriptive statistics for left and right posterior joint space for samples in two groups

Findings in the control group were in accordance with the study by Rodrigues et al[13]. Taking into account the results of Rodrigues et al[13] and the findings of the control group in the present study, we conclude that increase in the PJS does not seem to be a feature specific for increase overjet and overbite.

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In the present study, when PJS was compared between the left and right joints in the normal overjet group it was found to be statistically significant with P=0.0156 in contrast to the study by Cohlmia et al .[5] While similar comparison in the increased as well as excessive overjet groups showed insignificant results. For left joint, the comparison of normal and increased overjet subjects (P=0.027) as well as for the normal and excessive overjet subjects (P=0.039) was statistically significant. However, for the right joint similar comparison was insignificant. (Table 7A)

	Posterior joint space (mm)							
	Left Joint				Right Joint			
Overjet (mm)	N	Mean	SD	Median	Mean	SD	Median	*P*-value*
Normal (1-3 mm)	20	2.58	0.55	2.45	3.02	0.83	2.90	**0.0156**
Increased (3-6 mm)	9	3.32	1.17	3.20	3.33	1.39	2.90	0.9706
Excessive (> 6 mm)	7	3.21	0.93	3.20	3.04	0.78	2.70	0.6649
Normal vs. Increased †	**P = 0.027**				P = 0.459			
Normal vs. Excessive †	**P = 0.039**				P = 0.956			

Table 7A: Descriptive statistics for left and right posterior joint spaces according to overjet measurements

In the overbite group, significant results were found with P=0.0156 when comparison was done for the left and right joints in the normal group. This was in contrast to the study by Cohlmia et al.[5] Similar comparison in the increased group showed insignificant results. The comparison of normal and increased overbite groups for left joint when compared for the PJS was statistically significant with P=0.005. Similar comparison for the right joint showed insignificant results. (Table 7B)

	Posterior joint space (mm)							
	Left Joint				Right Joint			
Overbite (mm)	N	Mean	SD	Median	Mean	SD	Median	*P*-value*
Normal (1-3 mm)	20	2.58	0.55	2.45	3.02	0.83	2.90	**0.0156**
Increased (3-6 mm)	22	3.14	0.67	3.20	3.31	0.90	3.10	0.3702
Excessive (> 6 mm)	2	2.35	0.07	2.35	2.40	0.42	2.40	-
	P = 0.005				P = 0.285			
	-				-			

*****Obtained using *paired t-test;* †P-value obtained using t-test for independent samples
Table 7B: Descriptive statistics for left and right posterior joint spaces according to overbite measurements

Diagnosing TMJD based on the values of PJS in patients with increased overjet and overbite is not appropriate as considerable amount of asymmetry was found between left and right TMJ even in normal subjects. Therefore, making a definite conclusion based on the value of PJS does not seem appropriate.

PERCENTAGE OF JOINT SPACES (PJS AND AJS)

The formula used for representation of condylar position as percent displacement stated that a perfectly centered condyle would be expressed as 0%. Also, a positive value was indicative of anterior condylar positioning and a negative value was indicative of posterior condyle positioning.[5]

In the present study, when the left and right joints were compared for percentage of joint spaces (PJS and AJS) in the control group, no statistically significant results were found which is in accordance with the study by Cohlmia et

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al[5]and Prabhat et al.[12] However, similar comparison in the study group showed statistically significant results with P= 0.0106 which was in contrast to the study by Cohlmia et al[5] and Prabhat et al. [12] The comparison of control and study groups for percentage of joint spaces individually on left and right joints showed insignificant results. (Table 8)

Group	Percentage of joint space	N	Mean	SD	Min	Max	*P*-value			
							Control*	Study*	Left**	Right**
							Left vs Right	Left vs Right	Study vs Control	Study vs Control
Control	Left	20	28.57	14.2	3	52.2	0.1172	**0.0106**	0.3665	0.3807
	Right	20	36.52	17.6	0	54.8				
Study	Left	40	25.04	13.9	2.2	56.8				
	Right	40	32.34	16.3	0	69.8				

*****Obtained using *paired t-test;* ** Obtained using *t-test for independent samples*

Table 8: Descriptive statistics of percentages of posterior to anterior joint spaces for left and right joints for samples in two groups

Moreover, it was observed that both in the control and study groups, a positive value of the percentage of joint spaces was present which was indicative of anterior condylar positioning. The results of the present study are in accordance with that of Vitral et al[14], Rodrigues et al[15], Rodrigues et al[13], and Prabhat et al[12] but was in contrast to that concluded by Cohlmia et al[5] who stated concentric position of condyle in the mandibular fossa.

This indicates that anterior positioning of the condyle is not a feature specific to patients with increased overjet and overbite and may be found in patients with normal anterior teeth relationship.

In agreement with the results of Cohlmia et al[5], the present study concluded that correlation of the means of the left and right joints for percentage of joint spaces (AJS and PJS) in the normal (1-3mm), increased (3-6mm) and excessive(>6mm) overjet groups was statistically insignificant. Also, for the individual left and right joints no statistically significant results were found when comparison was done for the normal and increased as well as for the normal and excessive overjet groups. (Table 9A)

Overjet (mm)	Percentage of joint space							
	Left Joint				Right Joint			
	N	Mean	SD	Median	Mean	SD	Median	*P*-value*
Normal (1-3 mm)	20	28.57	14.16	28.80	36.52	17.62	43.65	0.1172
Increased (3-6 mm)	9	26.17	16.74	25.49	29.97	18.57	34.62	0.4702
Excessive (> 6 mm)	7	22.72	10.85	23.94	30.08	17.35	25.49	0.3063
Normal vs. Increased †	P = 0.693				P = 0.370			
Normal vs. Excessive †	P = 0.331				P = 0.412			

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Table 9A: Descriptive statistics of percentages of posterior to anterior joint spaces for left and right joints for samples in two groups according to overjet measurements

The present study found that the correlation of the left and right joints for percentage of joint spaces (AJS and PJS) in the normal overbite (1-3mm) group was statistically insignificant. This is in agreement with the study by Cohlmia et al[5]. However, similar comparison in the increased (3-6mm) overbite group was statistically significant (P=0.0078), in contrast to the results of Cohlmia et al[5]. Also, for the individual left and right joints no statistically significant results were found when comparison was done for the normal and increased overbite groups. (Table 9B)

	Percentage of joint space							
	Left Joint				Right Joint			
Overbite (mm)	N	Mean	SD	Median	Mean	SD	Median	*P*-value*
Normal (1-3 mm)	20	28.57	14.16	28.80	36.52	17.62	43.65	0.1172
Increased (3-6 mm)	22	24.50	13.63	22.33	34.86	15.92	35.96	**0.0078**
Excessive (> 6 mm)	2	33.97	22.66	33.97	23.07	11.57	23.07	-
	P = 0.384				P = 0.750			
	-				-			

*****Obtained using *paired t-test;* †P-value obtained using t-test for independent samples

Table 9B: Descriptive statistics of percentages of posterior to anterior joint spaces for left and right joints for samples in two groups according to overbite measurements

The severity of overjet is unrelated to the positioning of the condyle in the glenoid fossa and thus the role of percentage of joint spaces in determining TMJD is not of diagnostic value.
In case of overbite, considerable amount of asymmetry may be found between left and right TMJ with regard to percentage of joint spaces, in subjects with mild to moderate overbite. But similar conclusion could not be drawn in subjects with excessive overbite due to smaller sample size in the present study.
The severity of overbite seems to be unrelated to percentage of joint spaces, when individual assessment of the left and right TMJ was done. Therefore, individual joint wise assessment of the TMJ for percentage of joint spaces does not appear to be a useful parameter for diagnosing TMJD.
Research has suggested that joint space measurements and determination of condylar position is of questionable value, given the high variability of condylar position within the fossa in the adult population.

MRI IN TMJ

Currently, MRI is considered the most appropriate method for TMJ examination.[11] In the 1980's, MRI was used for the first time introducing the so-called surface spool for examination and featuring of TMJ structures. Many studies reported that the TMJ hard and soft tissues are best demonstrated by using MRI.[10]
In the present study, MRI was performed only for patients who were having increased overjet and / or overbite and were symptomatic for TMJD. In the present study, only 4 subjects were found to be symptomatic for TMJD and moreover all these 4 subjects had increased overbite, no subjects having increased or excessive overjet were found to be symptomatic.
Darendeliler et al have suggested that TMJD in subjects with an increased overbite may be attributed to the large angle of rotation of the condyle in such subjects.[16]
There were 5 parameters examined on the MRI and none of them showed statistically significant results when the left and right joints were compared. (Table 10)

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Table 10: Descriptive statistics for MRI variables for left and right joints

		Mean ± SD (Median)		
MRI	N	Left joint	Right joint	*P*-value
Eh	4	0.70 ± 0.06 (0.69)	0.64 ± 0.10 (0.67)	0.4734
Pgph	4	0.55 ± 0.04 (0.56)	0.49 ± 0.07 (0.48)	0.2098
Fd	4	0.55 ± 0.03 (0.55)	0.59 ± 0.07 (0.58)	0.3823
ec-fd	4	1.13 ± 0.06 (1.13)	1.12 ± 0.05 (1.12)	0.6895
eh/pgph	4	1.27 ± 0.12 (1.25)	1.30 ± 0.18 (1.24)	0.8085

*****Obtained using *paired t-test*

In the study by Wohlberg et al[6], however similar comparison of subjects with deepbite without gingival contact and deepbite with gingival contact the pgph was decreased in both left and right joints but was significant for the left joint. The eh/pgph ratio was also found to be increased on both left and right joints. However, no statistical association was found for the ratio in deepbite without and with gingival contacts.

Tvrdy [10] in his review on methods of imaging for TMJD has reported that although MRI has been demonstrated to be the best method of imaging TMJ hard and soft tissue but there is no connection between these changes shown by MRI and the clinical symptoms of TMJD.Since in the present study, a very small symptomatic group of merely 4 subjects was present, drawing a definite conclusion about the diagnostic value of MRI would not be appropriate.

Subjects in the study group demonstrated a larger AJS as compared to subjects in the control group. Although, AJS was larger than the control group but it was smaller than the PJS thereby the ratio between the PJS and AJS was more than 1 indicating an anteriorly positioned condyle. Also, the condyle was not positioned in the centric position even in the control group. But, greater condylar decentralization was seen in the study group which was statistically significant.

This difference though significant, only 10 % of the subjects (4 out of 40 subjects in the study group) were symptomatic supporting the idea that wide ranges of overjet or overbite are compatible with a normal function of masticatory muscles and the TMJ as perceived by the individual.

Conclusion

Currently, there is consensus that the cause of TMJD is multifactorial and the association of overjet and overbite with TMJD is still a matter of debate. Assessing such relationship would be of great benefit to the subjects with TMJD as corrections of increased overjet and overbite may prevent the subjects from the burden of most common symptom of pain associated with such condition. Corrections of increased overjet and overbite are much easier and permanent as compared to the varied treatment options available for TMJD, which for most of the times are not successful. However, attempting to prevent TMJD by creating more normal values of overbite or overjet with dental treatment does not seem to be appropriate. Therefore other causes of TMJD should be assessed even in subjects having increased overjet and overbite.

Limitations and Future Studies

The present study has potential limitations such as small sample size and we were unable to recruit a large number of symptomatic subjects having increased overjet and overbite in our study group and therefore further long term studies should be done so as to assess the relationship of increased overjet and overbite with TMJD.

Overjet and overbite are not responsible for causing TMJD and therefore treatment of overjet and overbite for TMJD is inappropriate. Also, the contribution of other important factors causing TMJD in a biologically multifactorial system should not be neglected.

The study made some novel observations that will unquestionably contribute in providing a platform for further research. We believe that these new perspectives will provide insight in reaching a clear consensus regarding relationship of increased overjet and overbite and TMJD.

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