Signs of Temporomandibular Disorders in Patients With Horizontal Mandibular Deficiency

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This study assessed the relationship between temporomandibular disorders (TMD) and malocclusion in a group of 102 patients with horizontal mandibular deficiency who had elected mandibular advancement surgery. The prevalence of TMD as reflected by the overall Craniomandibular Index, Dysfunction index, and Muscle index scores was within the range of nonTMD populations (mean Craniomandibular Index = 0.14; mean Dysfunction index = 0.12; mean Muscle index = 0.15). Forty-two percent of the patients exhibited essentially no signs of TMD, 7.8% had primarily muscle tenderness to palpation, 36.3% had joint sounds with or without temporomandibular joint tenderness, and 13.7% had combined muscle-joint signs. There were no convincing correlations among any of the cephalometric variables and Craniomandibular Index, Dysfunction index, and Muscle index scores. A subgroup of 30 of this patient population was evaluated both before and during orthodontic treatment just prior to surgery. No statistically significant changes were found in Craniomandibular Index, Dysfunction index, or Muscle index scores. Thus, a period of orthodontic treatment in these patients does not appear to increase the probability of TMD.
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Temporomandibular disorders (TMD) includes a number of clinical problems involving masticatory musculature and/or temporomandibular joints (TMJ).[1] Several initiating, predisposing, and perpetuating factors have been identified; however, the etiology of the various conditions remains unclear.[1] There is popular support for the concept that malocclusion is a factor in a subset of patients with TMD.[2] Numerous studies have explored the relationship between malocclusion and TMD.[3–13] Some of these studies indicate that specific types of malocclusion may be associated with the occurrence of TMD. In children and adolescents, posterior crossbite,[14] unilateral posterior contact in retruded position, and dental wear[15] are correlated with TMJ clicking. In addition, some clinicians hold the opinion, based upon their clinical experience, that prevalence of mandibular dysfunction is higher in individuals with an Angle Class II relationship than in those with an Angle Class I relationship. Positive correlations have been reported between Class II molar relationship and muscle tenderness in adolescents.[14] Also, the presence of a deep bite, open bite, and posterior crossbite has been correlated with the frequency of TMD signs and symptoms.[13,16] Finally, an autopsy study in young adults[5] found a correlation between increased overjet and overbite and remodeling in the TMJ. These studies support the belief that long exposure to malocclusion may be associated with changes in the TMJ and changes in mandibular function. However, other investigations have found no significant relationship between muscle tenderness and Angle classification,[5,7] or between an increased overjet or overbite and TMD signs and symptoms.[9,15] Thus, controversy exists as to whether a relationship exists between skeletal malocclusion and TMD.

Although most epidemiologic studies indicate that occlusal factors are not the major cause of TMD (for review, see McNamara et al[17]), well-designed studies may yet reveal a relationship in some cases. There has been concern that the lack of positive findings may be a result of the use of nonhomogeneous groups, which may mask infrequent but important occlusal etiologic factors.[18] The purpose of this study was to assess the relationship between TMD and the degree of malocclusion as represented by the cephalometric variables in a relatively homogeneous group of patients with horizontal mandibular deficiency who had elected mandibular advancement surgery.

Materials and Methods

Patients

The 102 patients examined in the study were enrolled in a clinical trial comparing wire versus rigid fixation techniques for bilateral sagittal split osteotomy. The sample consisted of 27 males and 75 females with a mean age of 29.0 years (range 14.6 to 47.9 years). The subjects were assessed during a 3-year period at the University of Texas Health Science Center at San Antonio (n = 52); Emory University, Atlanta (n = 27); and the University of Florida, Gainesville (n = 23). Patients were eligible to participate if they were at least 14 years of age with a horizontal mandibular deficiency that, in the opinion of their orthodontist and oral and maxillofacial surgeon, made them candidates for surgical mandibular advancement via bilateral sagittal split osteotomy. Patients who *(1)* had previously undergone maxillary surgery (including rapid palatal expansion and/or Le Fort I osteotomies) at least 6 months prior to this surgery, and *(2)* required concomitant genioplasties, subapical procedures, and/or augmentations to the malar regions were eligible for the study. The following exclusion criteria were used: *(1)* any medical, physical, or mental condition that would impair the patient's ability to follow instructions or that would place him or her at surgical risk (ie, rheumatoid arthritis and joint pathology); *(2)* edentulous patients or patients with fewer than 20 teeth total or 10 teeth in either arch, or patients with severe periodontal disease as determined by the surgeon; *(3)* patients requiring simultaneous two-jaw surgery; *(4)* patients with identifiable craniofacial deformities; *(5)* patients who had previously undergone mandibular advancement procedures; and *(6)* females who were pregnant as determined by self-report.

Assessments

The Craniomandibular Index (CMI) was used to provide a standardized assessment of the TMJs and jaw muscles.[19] The CMI consists of two subindexes: the Dysfunction index (D_i) and the Muscle index (M_i). All three indexes range from 0 to 1, with 1 indicating the highest level of clinical dysfunction. The index allows separate assessment and comparative scoring for *(1)* jaw movement and range of motion, *(2)* TMJ noise such as clicking and crepitus, *(3)* tenderness of specific muscle groups, and *(4)* TMJ tenderness. In addition, it provides an overall index of dysfunction with comparative norms. This scale was selected because of its high overall interrater (.84 to .95) and intrarater (.86 to .95) reliability.[19] The clinical procedure for this examination was performed as described by Fricton and Schiffman.[19] The five participating examiners were trained and calibrated yearly by Fricton.

Assessments of facial and skeletal morphology were not performed during the clinical examination. Assessments of internal derangements were performed during clinical examination; no joint imaging was done.

Lateral cephalometric radiographs were obtained in a Wheimer cephalostat (Wheimer, Franklin Park, IL) with a standard cathode-to-ear rod distance of 60 inches and a midsagittal head-to-film distance of 15 cm. A Wheimer calibration ruler (Wheimer) was mounted on the cephalostat. Cephalometric pencil tracings on acetate paper were made, and x and y coordinates for landmarks were digitized on a Hipad TM 1200 series digitizer (TM, Houston Instruments, Houston, TX) interfaced with an IBM PC XT computer system using a software program Ceph-Master (Tribolyte

Software, Ann Arbor, MI). The reference points and reference lines were drawn as described by Riolo et al.[20] The cephalometric variables used in this study were cephalometric overjet; anteroposterior angular skeletal base discrepancy variable (ANB); skeletal base discrepancy to occlusal plane (WITS); maxillary horizontal position (SNA); anteroposterior mandibular position (SNB); and anterior cranial base to mandibular plane angle (SN-GoGn).

The majority of the subjects (n = 72) were initially examined after presurgery orthodontics was initiated (treatment phase 2 [T2]). The CMI examination and cephalometric exposures were performed within 2 weeks before surgery (T2) at a time when the appliances had not been recently activated. Thirty patients were tested before (treatment phase 1 [T1]) and during orthodontic treatment (T2) to determine if CMI scores would be affected by the initiation of orthodontics. The mean time period between the two tests was 13 months (range 2 to 32 months).

The patients were classified into four mutually exclusive diagnostic subgroups according to Schiffman et al[21]: group 1, the asymptomatic group, consisting of individuals who essentially did not have muscle and/or joint symptoms; group 2, the joint group, defined by the presence of popping or reproducible reciprocal clicking without the presence of course crepitus, and passive stretch greater than 35 mm with or without joint tenderness to palpation; group 3, the muscle group, defined by the presence of six or more masticatory muscle sites tender to palpation; and group 4, the combined joint-muscle group, defined by a combination of symptoms from the joint group and muscle group.

Statistical Methods

The CMI, the M_i, and the D_i were correlated with the cephalometric variables using Spearman's rank correlation coefficient. The analysis was performed for the total group (n = 102) and the four diagnostic groups (ie, the asymptomatic group [n = 43]; the muscle group [n = 8]; the joint group [n = 37]; and the combined muscle-joint group [n = 14]).

One-way analysis of variance (ANOVA) was used to compare cephalometric variables among the four diagnostic subgroups. Wilcoxon's signed rank test was used to compare CMI, D_i, and M_i scores before and during orthodontic treatment for the 30 patients who entered the study before orthodontics was initiated. A significance value of .05 was used for all tests.

Results

At the immediate presurgical exam (T2), 43 patients (42.2%) exhibited essentially no signs or symptoms of TMD (mean CMI = 0.06, mean D_i = 0.05, mean M_i = 0.06); eight patients (7.8%) had primarily muscle tenderness (mean CMI = 0.25, mean D_i = 0.15, mean M_i = 0.33); 37 patients (36.3%) had joint signs and symptoms in various degrees of severity (mean CMI = 0.14, mean D_i = 0.16, mean M_i = 0.14); and 14 patients (13.7%) had combined muscle and joint signs (mean CMI = 0.32, mean D_i = 0.25, mean M_i = 0.39). The severity of malocclusion was examined by TMD subgroup; no statistically significant differences were found. Means, standard deviations (SD), and results of the ANOVA are presented in Table 1.

The results for the subgroup of 30 patients who were evaluated before orthodontics (T1) and

Table 1 Means (SD) and Results of ANOVA Comparing Morphologic Features of Patients*

Group	n	OJ	SNA	SNB	SN-GoGn	WITS	ANB
1	43	8.3 (1.9)	80.1 (3.5)	74.5 (4.4)	32.3 (8.1)	4.8 (2.4)	5.7 (2.1)
2	8	7.6 (2.5)	81.3 (3.7)	74.4 (4.8)	34.1 (9.6)	4.1 (2.0)	6.9 (2.6)
3	37	7.3 (2.6)	79.8 (3.6)	73.6 (3.6)	36.0 (7.1)	4.6 (3.3)	6.1 (2.7)
4	14	7.5 (3.1)	79.3 (4.5)	73.5 (4.6)	33.0 (6.6)	4.7 (3.8)	5.8 (2.7)
F value		1.152	0.520	0.406	1.55	0.106	
P value		0.332	0.669	0.749	0.206	0.956	

*Group 1 = patients with essentially no TMD signs; group 2 = patients with primarily muscular tenderness; group 3 = patients with primarily joint symptoms; group 4 = patients with joint and muscle signs; OJ = overjet; SNA = maxillary horizontal position; SNB = anteroposterior mandibular position; SN-GoGn = anterior cranial base to mandibular plane angle; WITS = skeletal base discrepancy reference to occlusal plane; ANB = anteroposterior angular skeletal base discrepancy.

Table 2 Craniomandibular Index, Dysfunction Index, and Muscle Index Scores for Patients Evaluated Before and During Orthodontic Treatment

	Mean (SD)	Median	P*
D_i before	0.17 (0.13)	0.15	.42
D_i during	0.15 (0.11)	0.15	.42
M_i before	0.18 (0.19)	0.08	.32
M_i during	0.20 (0.19)	0.18	.32
CMI before	0.18 (0.14)	0.17	.56
CMI during	0.17 (0.14)	0.16	.56

*Wilcoxon's signed rank test.

Table 3 Cephalometric Variables for the Total Group

Variable	Mean (SD)	Median
Overjet	7.80 (2.70)	7.00
WITS	4.68 (2.40)	7.63
ANB	5.94 (2.41)	5.84
SNA	79.97 (3.70)	80.43
SNB	74.02 (4.13)	73.97
SN-GoGn	33.58 (7.78)	33.36

Table 4 Spearman's Rank Correlation Coefficients Between Cephalometric Variables and D_i, M_i, and CMI Scores for the Total Group

	D_i	M_i	CMI
Overjet	−.07	−.03	−.05
WITS	−.09	−.07	−.08
ANB	−.04	−.01	−.02
SNA	−.23*	−.11	−.17
SNB	−.18	−.10	−.14
SN-GoGn	.18	.12	.16
Mean (SD)	.12 (.09)	.15 (.15)	.14 (.11)
Median	.12	.11	.11

*$P \leq .05$.

within 2 weeks of surgery (during orthodontics) (T2) are shown in Table 2. No statistically significant differences in CMI, D_i, or M_i scores were found after initiation of orthodontic treatment. Therefore, the CMI indexes of patients actively undergoing orthodontic treatment (T2) were used for further analyses.

Results from the cephalometric analysis for the total group are shown in Table 3. As shown, the patients in this study had a Class II skeletal relationship (mean WITS 4.68; mean ANB 5.94) and excessive overjet (mean 7.80). The subjects had a normal mandibular plane angle (mean 33.58).

Mean and median D_i, M_i, and CMI scores as well as the relationships between the cephalometric measures of malocclusion and dysfunction are shown in Table 4. The mean D_i, M_i, and CMI scores were 0.12 (± 0.09), 0.15 (± 0.15), and 0.14 (± 0.11), respectively. The scores were not correlated with overjet, WITS, ANB, SNB, or SN-GoGn. However, a weak negative relationship (P = .05) between the D_i score and the SNA was observed.

Discussion

The population studied consisted of a relatively uniform group of 102 patients with varying degrees of horizontal mandibular deficiency. The purpose of this study was to assess the possible relationship between TMD and the degree of malocclusion. No differences in malocclusion were found between a group of individuals essentially free of TMD signs and a group having muscle symptoms, a group having joint symptoms, or a group with both muscle and joint symptoms. In the total sample, only one statistically significant association between D_i, M_i, and CMI scores and malocclusion/cephalometric variables was observed: a weak negative correlation between maxillary horizontal position (SNA) and D_i score. This correlation suggests that a more retrusive maxilla may be associated with a higher level of dysfunction. This result must be cautiously interpreted because the correlation was only .23 and accounts for only 5.29% of the variance. Given the large number of correlations that were examined, this may likely be a chance correlation.

The prevalence of signs of TMD in our patients with horizontal mandibular deficiency is comparable to that of a nonpatient population: 57.8% of our patients were found to have some masticatory muscle and/or joint signs and symptoms; while in the nonpatient population studied by Shiffman et al,[21] 69% had masticatory muscle or joint problems. When our patients were classified into four diagnostic subgroups, according to the classification system of Shiffman et al,[21] the prevalence of asymptomatic group, joint disorders, muscle disorders, and combined muscle-joint disorders was 42.2%, 36.3%, 7.8%, and 13.7%, respectively. Although the prevalence of joint signs and symptoms in our patient group was higher than that of a nonpatient population,[21] it was markedly lower than the prevalence of symptomatic internal derangement in orthognathic surgery patients previously reported by Eriksson et al.[22] Muscle tenderness was slightly lower in our patients than in a study by Bush,[5] who found muscle tenderness to palpation in 14% of the subjects with Class II malocclusion. Muscle tenderness in a nonpatient population has been found to be higher—approximately 23%.[21] Overall, the severity of signs of temporomandibular disorders, as reflected by the overall CMI, D_i, and M_i scores, was rather low in our sample. These results suggest that patients with Class II malocclusion are not at greater risk for developing TM signs or mandibular dysfunction because of their malocclusion.

A potential limitation of this study is that the CMI assessments were made while the subjects were undergoing orthodontic treatment. To determine if presurgical orthodontic treatment affected the CMI, 30 patients were evaluated both before and during orthodontic treatment. There were no statistically significant changes in the CMI, D_i, or M_i scores. In fact, the scores were nearly identical. Thus, the initiation of orthodontic treatment in this population did not induce or reduce signs and symptoms of mandibular dysfunction. Despite some reports suggesting that initiation of orthodontic treatment may either increase the risk of developing TM problems[23,24] or enhance the health of the TMJ and masticatory system,[25–27] our findings are comparable to those of others who studied the long-term effects of orthodontic treatment on TMD signs and symptoms.[28–33] This supports the theory that the masticatory system is highly adaptive to the gradual changes induced by the orthodontic mechanotherapy.[12] It also suggests that our results may generalize to Class II subjects who are not in orthodontics.

Our group of patients was relatively homogeneous: to decrease the number of confounding variables, cases requiring maxillary surgery to close an open bite were not included. The prevalence of symptomatic joint dysfunction in our group is similar to the results of Kerstens and coworkers[34] who have shown a higher prevalence of joint dysfunction and TMJ symptoms among normal- and low-angle cases as compared to patients with high angles. Solberg et al[6] found a correlation between large overjet and extensive remodeling of TMJs of young adults at autopsy, supporting the concept that long exposure to malocclusion may result in changes in the TMJ and mandibular function. However, the Dysfunction index in our patient group did not correlate with the amount of overjet. This indicates that although morphologic changes may take place in these joints, the changes do not necessarily result in clinical evidence of TM dysfunction as assessed by the Dysfunction index in young adults, even with a significant degree of malocclusion. Interestingly, our data indicate that a more retrusive maxillary position was associated with greater dysfunction. Although the correlation was weak, this finding may warrant further investigation.

A weakness in this study is the reliance on clinical examination as a gold standard for diagnosis of joint dysfunction. An imaging study utilizing both TMJ arthrography and clinical evaluation[22] showed that 52% of patients undergoing orthognathic surgery had preexisting symptomatic internal derangement. Paesani et al[35] showed that there is a poor correlation between imaging studies and clinical examination for the evaluation of internal derangements. Despite these concerns, we believe that the clinical evaluation is a valid assessment of internal derangement and joint dysfunction given the poor correlation between imaging and symptoms.

Conclusion

In the present study, the prevalence and severity of signs of temporomandibular disorders in patients with varying degrees of horizontal mandibular deficiency are comparable to that of a general nonpatient population. Patients with and without symptoms did not differ with respect to measures of malocclusion, and TMD signs were not correlated with severity of malocclusion. The study suggests that initiation of orthodontic treatment does not influence, predispose to, or induce TMD. This study supports the findings of Behrents and White,[36] who stated that "Any relation that might exist between structure (dental and osseous) and temporomandibular disorders is not simple, frequent or dramatic."

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Resumen

Signos de los Desórdenes Temporomandibulares en Pacientes con Deficiencia Mandibular Horizontal

Este estudio evaluó la relación entre los desórdenes temporomandibulares (DTM) y la maloclusión en un grupo de 102 pacientes con deficiencia mandibular horizontal, quienes habian elegido cirugía de avance mandibular. La prevalencia de los DTM tal y como reflejada por los resultados en conjunto del Indice Craneomandibular, de Disfunción y el Muscular, estaba dentro de los límites de las poblaciones no afectadas por DTM (media del Indice Craneomandibular = 0,14; media del Indice de Disfunción = 0,12; media del Indice Muscular = 0,15). El 42% de los pacientes no presentaban esencialmente signos de DTM, el 7,8% sufrían principalmente de sensibilidad muscular a la palpación, el 36,3% tenían sonidos articulares con o sin sensibilidad de la ATM, y el 13,7% tenían signos combinados musculo-articulares. No existían correlaciones convincentes entre ninguna de las variables cefalométricas y los valores de los Indices Craneomandibular, de Disfunción y Muscular. Se evaluó un subgrupo de 30 pacientes de esta población, antes y durante el tratamiento ortodóntico justo antes de la cirugía. No se encontraron cambios estadísticamente significativos en los valores de los Indices Craneomandibular, de Disfunción o el Muscular. Por lo tanto, un periodo de tratamiento ortodóntico en estos pacientes no parece aumentar la probabilidad de presentar DTM.

Zusammenfassung

Zeichen von Myoarthropathien bei Patienten mit Retrogenie

Diese Studie beurteilte die Beziehung zwischen Myoarthropathien (MAP) und Malokklusion bei einer Gruppe von 102 Patienten mit Retrogenie, die sich zu einer chirurgischen Vorverlagerung des Unterkiefers entschlossen. Die Prävalenz von MAP, bestimmt durch den Craniomandibular Index, Dysfunction Index und Muscle Index ist vergleichbar mit derjenigen der durchschnittlichen Bevölkerung (durchschnittlicher Craniomandibular Index = 0.14, Dysfunction Index = 0.12, Muscle Index = 0.15). 42% der Patienten zeigten keine Zeichen von MAP, 7.8% hatten in erster Linie Druckdolenzen der Muskulatur, 36.3% wiesen Gelenkgeräusche mit oder ohne Gelenkschmerzen und 13.7% hatten kombinierte Muskel-Gelenk-Befunde. Es gab keine überzeugende Korrelation zwischen einem der kephalometrischen Werte und dem Craniomandibular Index, Dysfunction Index und dem Muscle Index. Eine Untergruppe von 30 dieser Patienten wurde vor und während der kieferorthopädischen Behandlung unmittelbar vor dem chirurgischem Eingriff untersucht. Es wurden keine statistisch signifikanten Veränderungen bei den drei Indizes gefunden. Dementsprechend scheint eine kieferorthopädische Behandlung bei diesen Patienten die Wahrscheinlichkeit für das Auftreten von Myoarthropathien nicht zu erhöhen.