Unilateral temporomandibular disorder and asymmetry of occlusal contacts

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Statement of problem. The relationship between temporomandibular disorders and occlusal tooth contacts is unclear and controversial.

Purpose. This study assessed whether unilateral temporomandibular disorders were associated with the absence of bilateral symmetry in the number of occlusal contacts.

Material and Methods. Fifteen university dental students who had complete natural dentition and normal occlusion and exhibited unilateral signs and symptoms of temporomandibular disorders were compared to 15 age- and sex-matched healthy control subjects. All participants met specific inclusion and exclusion criteria. Occlusal contacts were recorded in the intercuspal position with wax registrations. Dental impressions were made and poured in type I stone. Contacts were classified according to location and intensity. Four experienced dentists using an established protocol made all measurements. Assessment of the reliability of the occlusal registration procedure showed a small (<4%) within-subject variability. Statistical analysis was based on the binomial distribution and nonparametric tests ($P < .05$).

Results. Subjects with unilateral temporomandibular disorders had greater bilateral difference in the number of contacts than controls. The median (95% confidence interval) difference was 3 (2 to 4) and 2 (1 to 2), respectively. In unilateral temporomandibular disorder subjects, the number of occlusal contacts was greater on the side with, rather than without, disorder (median number 20 vs. 16). The median (95% confidence interval) difference between sides with and without unilateral temporomandibular disorders was 3 (2 to 4) for all contacts and 2 (1 to 3) for contacts on the posterior teeth.

Conclusion. Within the population of this study, a weak association was found between unilateral temporomandibular disorders and asymmetry in the number of occlusal contacts. (J Prosthet Dent 2003;89:180-5.)

CLINICAL IMPLICATIONS

The young adults with complete natural dentition and normal occlusion tested in this study demonstrated a weak association between unilateral signs and symptoms of temporomandibular disorders and asymmetry in the number of occlusal contacts.

Occlusion has been advocated as a causative factor in temporomandibular disorders (TMD).[1-4] The American Academy of Orofacial Pain has suggested that occlusion may play a role in the cause of TMD,[5] but the literature reports controversial and inconclusive results.[4,6-21] Significant associations of TMD with occlusion have been found,[4,8,9,12,15,17,18] especially with regard to the number of occlusal tooth contacts,[8,9,12,15,17] but these associations are only partially confirmed or not confirmed.[6,7,10,11,13,14,16,19] Nonhomogeneity in definitions, differences in data collection procedures, lack of control groups in some investigations,[6,11,16] diversity among populations, and varied admission criteria may have led to contradictory results. Moreover, the different methods and techniques used to record contacts,[22] the occlusal pressure used,[23,24] chair position, and head posture all may have influenced occlusal response.[25]

There is an obvious need to re-examine the hypothetical relationship between TMD and occlusion. Indeed, although several studies investigated patterns of occlusal contacts in healthy subjects,[22,26-33] little information is available in subjects with TMD,[8-12,15-17] and controlled trials designed to analyze asymmetries of occlusal contacts are lacking. Watanabe et al,[16] who suggested that a weak relationship may exist between signs and symptoms of TMD and occlusal contact patterns during lateral excursions, also emphasized that the specific laterality of TMD may be associated with particular occlusal contacts. These authors concluded that stringent case-control studies were needed to better clarify this issue.

This study assessed the possible association between unilateral temporomandibular disorders and a lack of bilateral symmetry in the number of occlusal contacts. The study population comprised young adults with complete natural dentitions and Angle Class I occlusion.

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MATERIAL AND METHODS

Fifteen subjects (8 women and 7 men, age 19 to 26 years) were selected from the 371 dental students consecutively enrolled at the University of Milan, Italy, from October to December 1999. The following eligibility criteria were used: complete natural dentition except for occasionally missing third molars; normal physiological occlusion as defined by Mohl[34] and bilateral Angle Class I molar and canine relation; no periodontal disease; good compliance with oral hygiene; no dental treatment in the 3 months before clinical evaluation; and unilateral presence of at least 2 signs or symptoms of temporomandibular disorder (temporomandibular joint [TMJ] sounds, pain on palpation of the TMJ or masticatory muscles, and/or painful limitation of mandibular movement).[35] Exclusion criteria were the presence of neurologic or cervical disturbances, any disabling complaint, and the presence of recurrent headaches.

Each subject with TMD was age- and sex-matched with a control subject who met modified admission criteria (signs and symptoms of TMD were excluded) and who was randomly selected (same chance within each age and sex stratum) from healthy students. The matched case-control design was adopted because it was believed to be a useful design for small investigations.[41] The Institutional Ethical Committee approved the trial protocol, and all participants gave oral informed consent.

Neurologic and cervical disturbances, as well as recurrent headaches, were identified as exclusion criteria because they were considered potential confounders. In fact, previous studies have suggested that these complaints may be associated with TMD or craniomandibular asymmetry.[36-40] Lack of third molars allowed in admission criteria may not have influenced the results, given that the number of contacts on third molars may be expected to be smaller than on first and second molars.[31-33] All third molars were present in 10 of 15 subjects with TMD (66.7%) and 9 of 15 control subjects (60.0%). The number of missing third molars did not differ between the right and left sides for either subjects with TMD or control subjects, and no difference was found between groups (minimum $P=.656$). In subjects with TMD, the number of missing third molars was not different between sides with and without signs and symptoms of TMD ($P=.815$). On the basis of these results, third molar contact was excluded from subsequent analyses.

Four experienced dentists (>10 years of clinical practice) assessed dental and TMD status. Thereafter, a single dentist made dental impressions and wax registrations for all subjects. Occlusal registrations of the dentition with a wax profile have been used previously[27,42,43] and were judged to be reproducible.[27] Each impression was poured in type I stone (Snow White Plaster #2; Kerr, Romulus, Mich.), and diagnostic casts were mounted in an articulator. The dentist registered the occlusal contacts with the following procedure. First, each subject was seated upright in a dental chair with his/her feet on the ground. The subject was asked to look straight at a white panel 2 meters away and mounted at eye level on a wall. This procedure enabled the subject to maintain a natural head position.[44-46] Second, the subject was asked to swallow and then to close into maximum intercuspation. He/she was instructed to apply moderate pressure to ensure that teeth were in contact but not to squeeze with heavy pressure. This procedure was repeated a minimum of 3 times, or until the subject could reliably perform the movement. Occlusal contacts were recorded at maximum intercuspation because it had been showed to be identical in the upright position, in the supine position, and with the body inclined at 30 or 60 degrees from the horizontal, provided the mandible was elevated voluntarily.[47] Subjects were instructed to apply swallowing pressure because it had been established to be within the range of pressure normally present during swallowing and chewing functions.[48,49] Thermally controlled U-shaped wax (Occlusal Indicator Wax; Kerr) 0.5 mm thick was gently placed on the mandibular occlusal surfaces. The subject was asked to swallow and then to close into maximum intercuspation as described previously. The dentist monitored the movement (Fig. 1). The examiner cooled and removed the wax record with tweezers and stored it in a tightly sealed and randomly-numbered stiff, plastic bag.

Fig. 1. Wax profile (0.5 mm thick) in mouth.

Another examiner, not involved in the examination and unaware of the subject's status, examined the wax records in front of a light screen[27] (Fig. 2). The intensity of contact was classified according to Myers and Anderson[26] and Ehrlich and Taicher.[27] Specifically, contact was defined as supra if penetration of the wax record was observed, normal if a translucent area was observed, and near if thinning of the wax was observed. Placing the wax record on the diagnostic cast and marking contacts

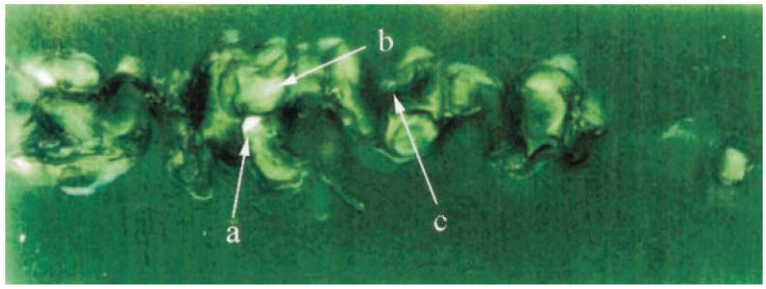

Fig. 2. Wax registration after clenching shows typical indentations: *(a)* supra-contact (penetration of wax), *(b)* normal-contact (translucent area), and *(c)* near-contact (thinning of wax).

Table I. Number of occlusal contacts in subjects with unilateral TMD and control subjects by teeth and intensity of contact

	Subjects with TMD (n = 15)					Control subjects (n = 15)					
	N	Mean	SD	Median	95% CI*	N	Mean	SD	Median n	95% CI*	*P* value†
Teeth of contact											
Any tooth	543	36.2	4.9	36	(35,40)	567	37.9	3.9	38	(34,40)	.504
Anterior‡	99	6.6	1.8	7	(6,8)	109	7.3	2.2	7	(7,9)	.187
Posterior§	444	29.6	5.2	30	(28,32)	458	30.5	3.7	31	(27,33)	.646
Intensity of contact											
Supra-contact	72	4.8	4.5	4	(0,7)	66	4.4	3.9	4	(1,7)	.916
Normal-contact	376	25.1	8.2	26	(16,34)	425	28.3	6.3	25	(24,36)	.289
Near-contact	95	6.3	5.4	3	(2,10)	76	5.1	2.6	4	(4,7)	.530

*Confidence interval for the population median.
†Significance of comparison between subjects with TMD and control subjects.
‡Incisors and canines.
§Premolars and molars.

on the occlusal surface of the cast determined the location of the contacts on premolars and molars. Location was defined according to the classification of Jordan et al.[50]

The validity and reliability of the occlusal registration procedure was assessed in 4 volunteers (2 subjects with TMD and 2 control subjects). Thirty occlusal records were obtained for each of these subjects during a period of 3 consecutive weeks. The registration sessions were performed between 8:30 and 9:30 AM. The interquartile range and the coefficient of variation (percentage ratio of standard deviation to mean) of the number of contacts were as follows: subject 1 (TMD), 35 to 38 and 4.1%; subject 2 (TMD), 34 to 36 and 3.7%; subject 3 (control), 35 to 37 and 3.8%; and subject 4 (control), 37 to 39 and 3.8%. The small within-subject variability and comparability of intersubject measurement variation were deemed to yield reliable occlusal data.

The sample size allowed detection of 100% difference or more between subjects with TMD and control subjects, in the bilateral difference of the number of contacts, with a type I error level of 0.05 and a power of 0.8. With a mean bilateral difference a value of 1.4 in control subjects and a standard deviation of 1.1,[22] a minimum of 10 subjects in each group was required.

Descriptive data were reported as mean, standard deviation, and median. The 95% confidence interval for the population median was calculated.[51] Comparison between proportions was made with a χ^2 test or on the basis of the binomial distribution when appropriate. Student's t test was used to compare normally distributed variables; for all other situations, nonparametric analysis was performed. The Mann-Whitney U-test was used to test differences between unpaired data, whereas the Wilcoxon signed ranks test and the Friedman test were used for comparisons between and among paired data. All values of $P<.05$ were considered to indicate statistical significance (2-tailed test).

RESULTS

Table I shows the distribution of the number of contacts (excluding third molars) in subjects with TMD and control subjects in relation to teeth and intensity of contact. No significant difference was found between groups ($P>.187$). The number of contacts was greater on posterior than anterior teeth ($P<.0001$), both in subjects with TMD (81.7%) and control subjects (80.0%). The prevalence of normal-contacts (69.2% in subjects with TMD, 74.9% in control subjects) was significantly higher than the prevalence of supra-contacts (13.2% in subjects with TMD, 11.6% in control subjects) and near-contacts (17.5% in subjects with TMD,

Table II. Absolute (signless) bilateral difference of the number of occlusal contacts in subjects with unilateral TMD and controls subjects by teeth and intensity of contact

	Subjects with TMD (n = 15)				Control subjects (n = 15)				
	Mean	SD	Median	95% CI*	Mean	SD	Median	95% CI*	*P* value†
Teeth of contact									
Any tooth	3	1.4	3	(2,4)	1.7	1.2	2	(1,2)	.015‖
Anterior‡	0.7	0.6	1	(0,2)	0.9	0.7	1	(0,2)	.775
Posterior§	2.5	1.3	2	(2,3)	1.6	1.3	1	(1,2)	.047‖
Intensity of contact									
Supra-contact	1.8	2.0	1	(1,3)	1.2	1.3	1	(1,2)	.697
Normal-contact	4.1	3.1	2	(2,6)	1.9	1.1	2	(1,3)	.085
Near-contact	1.6	1.4	1	(1,2)	1.1	1.3	1	(1,2)	.202

Absolute bilateral difference = Number of occlusal contacts on the right side − Number of occlusal contacts on the left side.
*Confidence interval for the population median.
†Significance of comparison between subjects with TMD and control subjects.
‡Incisors and canines.
§Premolars and molars.
‖Statistically significant.

Table III. Difference of the number of occlusal contacts between sides with and without signs and symptoms of TMD in subjects with unilateral TMD, by teeth and intensity of contact

	Mean	SD	Median	95% CI*	*P* value†
Teeth of contact					
Any tooth	2.7	1.9	3	(2,4)	.001‖
Anterior‡	0.6	0.7	1	(0,1)	.043‖
Posterior§	2.1	1.9	2	(1,3)	.003‖
Intensity of contact					
Supra-contact	−0.1	2.7	0	(−1,1)	.887
Normal-contact	3.2	4.1	2	(1,6)	.007‖
Near-contact	−0.3	2.1	0	(−2,1)	.520

*Confidence interval for the population median.
†Significance of the comparison between the observed difference and zero.
‡Incisors and canines.
§Premolars and molars.
‖Statistically significant.

13.4% in control subjects), both in subjects with TMD and control subjects ($P<.0001$).

In both groups, the posterior contacts (444 in subjects with TMD, 458 in control subjects) were more predominately located on the inner supporting cusps (61.7% in subjects with TMD, 64.6% in control subjects) than in the central fosses (27.2% in subjects with TMD, 27.1% in control subjects) or on the outer cusps (11.1% in subjects with TMD, 8.3% in control subjects) ($P<.0001$). No difference was found between subjects with TMD and control subjects ($P>.200$).

A within-subject analysis was performed to assess the presence of asymmetry in the number of contacts. Positive and negative differences between the number of contacts on right and left sides were similarly represented both in TMD and control groups. Therefore only absolute (signless) differences were considered for further comparisons between groups. A wide variability was observed, with the coefficient of variation ranging from 47% to 111% in TMD subjects and from 58% to 118% in control subjects. Asymmetry of contacts (absolute bilateral difference of the number of contacts) was significantly larger in unilateral subjects with TMD than in control subjects ($P=.015$) (Table II).

Perfect symmetry (bilateral difference equal to 0) was not found in any of the subjects with TMD but was found in 2 control subjects (13.3%) ($P=.482$). Ten subjects with TMD (66.7%) had bilateral difference equal to or greater than 3 contacts, compared with 3 control subjects (20.0%) ($P=.009$).

No difference in asymmetry was found between groups in relation to intensity of contact (minimum $P=.085$). In both groups, asymmetry of the contacts was significantly larger for posterior than anterior teeth ($P<.01$) and for normal- as opposed to supra- and near-contacts ($P=.01$) (Table II).

In the unilateral TMD group, 13 subjects (86.7%) had more contacts on the side with temporomandibular

disorder ($P=.001$). The number of normal-contacts was higher on the TMD side ($P=.007$), but no bilateral difference was found for supra- or near-contacts (Table III).

DISCUSSION

This investigation examined the possible association between unilateral TMD and a lack of bilateral symmetry in the number of occlusal contacts in a sample of young adults with complete natural dentitions and normal occlusion. Although the reference population was clearly identified, the possibility of biased selection of unilateral subjects with TMD cannot be excluded given the unusual correspondence of unilateral clinical findings and symptoms. From an epidemiologic perspective, such bias would be a limitation of this study. Experimental laboratory conditions were strictly defined and maintained. The same dentist made all occlusal registrations; another dentist, unaware of the subjects, inspected the occlusal registrations. The within-subject variability was satisfactorily narrow (approximately 4%).

In this study the presence of all third molars was similar to that recorded in other investigations.[31,33] No bilateral difference in the number of missing third molars was found; in unilateral TMD subjects, no difference was found between sides with and without signs and symptoms of TMD. However, because the effect of the third molar contact was not fully assessed, any generalization of the results should be made with caution.

An analysis of the pooled data revealed no significant difference between subjects with TMD and control subjects in relation to the number, location, and intensity of contacts. These results agree with some previous studies[6,10,11] but differ from others.[8,9,12,15,17] Once again, it should be recognized that some of these studies cannot be compared because of different study designs, methods of data collection, and assessments of occlusal conditions. In the present study, the mean number of occlusal contacts in both subjects with TMD and control subjects was within the range of earlier surveys (11[28] to 79[27]). Also in agreement with previous studies, the number of contacts was greater on posterior than anterior teeth.[22,26-30,32] Although these results confirm the importance of premolars and molars in the chewing process of subjects with TMD, they are expected, given the occlusal table in the molar area is greater in size.[22]

The within-subject analysis disclosed a weak association between unilateral TMD and asymmetry of contacts. Absence of perfect bilateral symmetry was common both in subjects with TMD (100%) and control subjects (86.7%) and did not differ significantly between groups. In other studies, the prevalence of perfect symmetry in healthy subjects ranged from approximately 5%[32] to 21%.[22] These results support the conclusion that asymmetry of contacts seems to be the rule rather than the exception, both in subjects with TMD and healthy subjects. Nevertheless, in this study, subjects with unilateral TMD exhibited greater asymmetry (bilateral difference of contacts ≥ 3) than control subjects (66.7% vs 20.0%). This result suggests that, although significant asymmetry may be relatively rare in healthy subjects (as also found by McDevitt and Warreth[22] and Korioth[32]), it is quite common in unilateral subjects with TMD. Indeed, the difference between TMD and control groups in terms of the number of asymmetrical contacts was essentially 1, regardless of whether the mean or median was used. Approximately 30 posterior contacts were recorded, which does not represent a very robust effect.

Several studies have evaluated asymmetries in patients with TMD, with special focus on electromyographic muscle activity and facial morphologic characteristics.[4,13,14,16,18,20,21] The results are controversial. In particular, it has been suggested that in subjects with TMD, asymmetry in occlusal relations may be related primarily to skeletal asymmetry.[21]

Because a cross-sectional study design was used, no etiologic conclusions can be drawn from the results. However, on the basis of the results, an independent association between unilateral TMD and asymmetry of occlusal contacts may be inferred. This conclusion is in agreement with Watanabe et al,[16] although the data collected in their study and this investigation differed. This difference can be attributed to the following factors: In this study, subjects were drawn from a nonpatient population; in Watanabe et al,[16] they were drawn from a clinical population of patients that may have had bilateral TMD. Moreover, Watanabe et al[16] evaluated contacts during lateral excursion, although this study evaluated contacts in the intercuspal position. These diverse occlusal positions may have led to different estimates of the prevalence of contacts.

Finally, the high concordance (86.7%) between the side with TMD and the side with the higher number of tooth contacts is not surprising. If a subject who exhibits unilateral signs and symptoms of TMD has a deranged joint, some shortening of the joint would be expected. In such a situation, more contacts on the disorder side would be expected, along with asymmetry of contacts. Large, longitudinal studies are necessary to confirm the results of this study and to clarify the nature of the relationship between TMD and occlusal tooth contacts.

CONCLUSIONS

Within the limitations of this study, a weak association between unilateral TMD and asymmetry of occlusal contacts was found in young adults with complete natural dentitions and normal occlusion. Absence of bilateral symmetry of contacts seemed to be the rule rather than the exception, both in subjects with TMD and

healthy subjects, but subjects with unilateral TMD exhibited relatively greater asymmetry.

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