Disclusion time measurement studies: A comparison of disclusion time between chronic myofascial pain dysfunction patients and nonpatients: A population analysis

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From a pool of 89 patients, 49 patients were classified as having chronic myofascial pain dysfunction syndrome (MPDS), and 40 were classified as asymptomatic or non-MPDS patients designated as the control group for the study. To achieve balanced sample size in both groups, 40 patients were arbitrarily selected from the MPDS group. All patients from each of the two primary groups were then categorized and assigned to one or more subgroups according to the following criteria: (1) jaw classification, (2) open occlusion, (3) previous orthodontic therapy, or (4) no previous orthodontic therapy. A fifth subgroup composed of only MPDS patients and equally divided into those who had or had not experienced orthodontic therapy was established to determine whether mean disclusion time differences occur between orthodontic and nonorthodontic MPDS patients. All 80 patients were evaluated for disclusion time of their right and left mandibular excursions to determine statistical population comparisons. Statistical assessment of right and left disclusion times for women and men in the MPDS and non-MPDS groups was performed separately for each of the five subgroups. Analysis of the comparisons revealed that in all except two of the subgroups, mean disclusion time was significantly longer in the MPDS patient group than in the non-MPDS group. The two subgroups in which this was not apparent were those with open occlusion and orthodontic patients compared with nonorthodontic patients. These findings suggest that lengthy posterior disclusion time may be of diagnostic importance when the differing etiologic factors of chronic MPDS patients are evaluated. (J PROSTHET DENT 1994;72:473-80.)

Disclusion time is defined as the duration of time that working and nonworking molars and premolars are in contact during a mandibular excursive movement that commences from the habitual closure position through to the contact of anterior guiding surfaces. Disclusion time measures the time with which posterior teeth separate from each other during jaw motion. Disclusion time was first described by Kerstein and Wright[1] for T-Scan (Tekscan, Inc., Boston, Mass.)[2-4] Force Movie[5] occlusal analysis of the right and left working excursions of seven female subjects.

Lengthy disclusion time was shown to increase contractile muscle activity in the masseter and temporalis muscles of seven women with chronic MPDS.[6,7] The reduction of lengthy disclusion time (Fig. 1) to short disclusion time (Fig. 2) was successfully accomplished by the method of occlusal adjustment known as immediate complete anterior guidance development.[1] Disclusion time reductions will reduce contractile muscle activity significantly and result in a reduction of chronic muscle dysfunction often associated with chronic MPDS patients.[1,6]

Population studies on disclusion time have not been reported. This study attempts to describe and compare measurable differences in disclusion time length between MPDS and non-MPDS patients.

MATERIAL AND METHOD

Forty chronic MPDS patients aged 18 to 41 years and 40 non-MPDS patients aged 22 to 38 years were compared as to the length of their disclusion times for right and left working mandibular excursions. Protrusive excursions were not analyzed. No treatment was provided to any patients before disclusion time measurement.

Those included in the two subgroups were young adults to middle-aged individuals who exhibited good overall health and had never experienced jaw trauma or surgery. The MPDS patients were required to use pain and anti-inflammatory medication only for specific chronic MPDS symptoms, but not for any other medical condition. The non-MPDS group was permitted to use routine nonnar-

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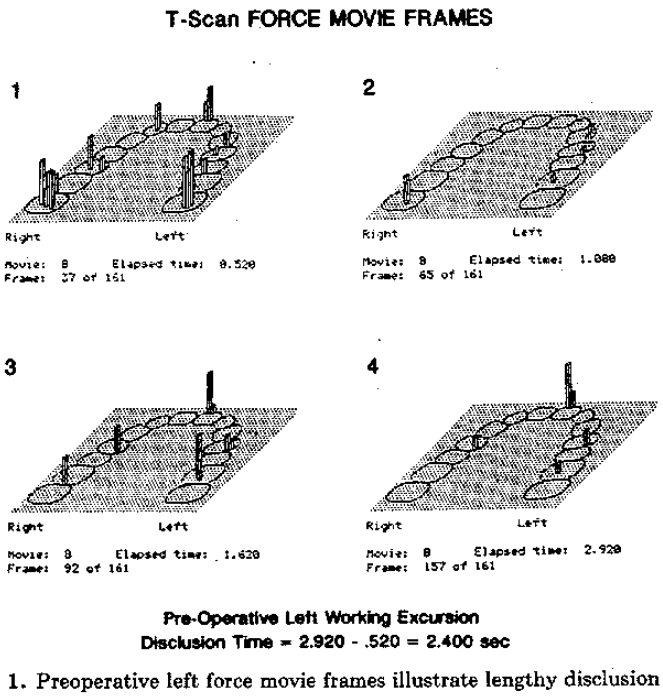

Fig. 1. Preoperative left force movie frames illustrate lengthy disclusion time.

Table I. Population pool characteristics

	MPDS patients	Non-MPDS patients
Men	22	20
Women	27	20
Total	49	40
Orthodontic	26	16
Open occlusion	10	10
Class I	23	20
Class II	14	10
Class III	12	10

Table II. Analysis of right and left disclusion times (in seconds) for men and women, MPDS and non-MPDS patients

Source	*df*	Mean square	F	*P*
Patient type	1	6.2528	13.90	0.0004
Gender	1	1.2093	2.69	0.1053
Type × gender	1	0.0023	0.01	0.9429
Error (between)	76	0.4499		
Side	1	0.0841	0.80	0.3752
Side × type	1	0.1363	1.29	0.2599
Side × gender	1	0.2318	2.19	0.1429
Side × type ×gender	1	0.1066	1.01	0.3186
Error (within)	76	0.1057		

Table III. Summary of descriptive statistics for right and left disclusion time (in seconds)

	Women		Men	
	Left	Right	Left	Right
MPDS				
Mean	1.546	1.314	1.585	1.608
SD	0.475	0.535	0.512	0.483
N	20	20	20	20
Non-MPDS				
Mean	1.033	1.021	1.190	1.227
SD	0.569	0.562	0.476	0.591
N	20	20	20	20

cotic pain medication for occasional head and neck discomfort such as an isolated headache.

Excluded from the two groups were children, adolescents, and the elderly, to approximate the age range in which chronic MPDS symptoms are seen clinically and most often. Also excluded were patients with edentulous jaw regions, previous jaw surgery, or compromised medical health that required a regimen of oral medication. In addition, patients with a known migraine headache condition who took daily headache medication were excluded.

The subgroup of 40 MPDS patients was composed of 20 women 18 to 37 years of age, and 20 men 20 to 41 years of age.

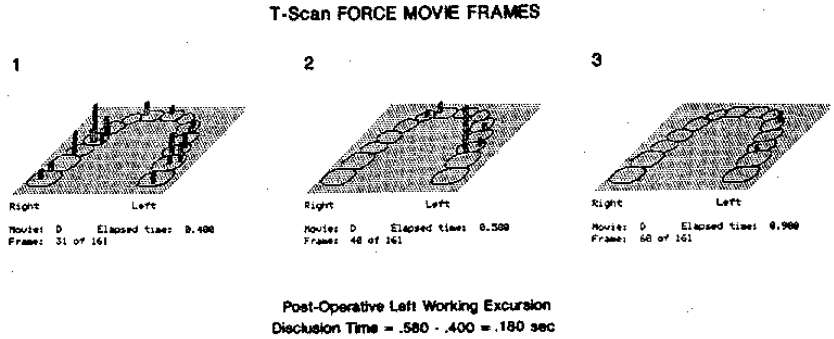

Fig. 2. Postoperative left force movie frames illustrate short disclusion time resultant from immediate complete anterior guidance development.

Of these patients, 20 previously had orthodontic therapy.

The patients' chronic disease status was ascertained by oral discussion of the history and symptomatic nature of their disease and evidence of no success from previous treatments such as splint therapy, chiropractic care, physical therapy, and biofeedback. All 40 patients had only partial if any resolution of their chronic condition despite previous therapeutic attempts.

An unmatched subgroup of 40 non-MPDS patients was selected as a control group for comparison. This group was composed of 20 women in the age range of 22 to 35 years, and 20 men in the age range of 22 to 38 years. Of these patients, 16 had previously undergone orthodontic therapy.

A history of the non-MPDS patients revealed no chronic symptoms of MPDS before this study and no current symptoms. No treatment had been needed and all were unaware of any problems regarding jaw function, jaw discomfort, headaches, or joint noises.

All 80 patients were currently enrolled in an ongoing private practice of prosthodontics and retained all of their permanent anterior teeth, at least four permanent premolars, and at least eight permanent molars. All had, at most, one crown and no other prostheses present. All were dentate with generally healthy oral conditions. The subgroup characteristics are described in Table I.

Disclusion time analysis by the T-Scan computer (Tek-Scan Inc., Boston, Mass.) and mathematical calculation was done as described in a previous study.[1] Disclusion times of the right and left mandibular excursions were measured twice for each patient. The two measurements were then averaged to obtain a single disclusion-time score for each patient's right and left excursions.

Right and left disclusion times in seconds for five subgroups of patients were analyzed by use of the analysis of variance (ANOVA) with repeated measures for one factor. The software program used to perform the analyses was PC BMDP (PC BMDP Statistical Programs, Los Angeles.) (1990 release). The five subgroups analyzed were:

Table IV. Analysis of right and left disclusion times (in seconds) for jaw angle classification, MPDS and non-MPDS, men and women

Source	*df*	Mean square	F	*P*
Class	2	3.1965	10.61	0.0000
Patient type	1	3.0274	10.04	0.0027
Gender	1	0.6021	2.00	0.1640
Class × type	2	0.0629	0.21	0.8125
Class × gender	2	0.3829	1.27	0.2899
Type × gender	1	0.0998	0.33	0.5678
Class × type × gender	2	0.5086	1.69	0.1958
Error (between)	48	0.3014		
Side	1	0.0276	0.25	0.6195
Side × class	2	0.0361	0.33	0.7232
Side × type	1	0.1320	1.19	0.2799
Side × gender	1	0.3786	3.43	0.0704
Side × class × type	2	0.1312	1.19	0.3139
Side × class × gender	2	0.0148	0.13	0.8747
Side × type × gender	1	0.0998	0.90	0.3468
Side × class × type × gender	2	0.0848	0.77	0.4699
Error (within)	48	0.1105		

1. Men and women, MPDS versus non-MPDS (included all 80 patients) (Tables II and III)
2. Men and women by jaw classification, MPDS versus non-MPDS (Tables IV through VII)
3. Men and women, MPDS versus non-MPDS, open occlusion only (Tables VIII and IX)
4. Men and women, MPDS versus non-MPDS, previous orthodontic patients only (Tables X and XI)
5. Men and women, orthodontia versus no orthodontia, MPDS patients only (Tables XII and XIII)

Table V. Summary of descriptive statistics for right and left disclusion time (in seconds) in class I patient group

	Women		Men	
	Left	Right	Left	Right
MPDS				
Mean	1.548	1.252	1.108	1.372
SD	0.425	0.388	0.279	0.622
N	5	5	5	5
Non-MPDS				
Mean	0.908	0.812	1.060	1.004
SD	0.297	0.307	0.433	0.503
N	5	5	5	5

Table VI. Summary of descriptive statistics for right and left disclusion time (in seconds) in class II patient group

	Women		Men	
	Left	Right	Left	Right
MPDS				
Mean	1.860	1.424	2.036	1.924
SD	0.332	0.552	0.643	0.336
N	5	5	5	5
Non-MPDS				
Mean	1.636	1.764	1.420	1.516
SD	0.612	0.447	0.608	0.712
N	5	5	5	5

Table VII. Summary of descriptive statistics for right and left disclusion time (in seconds) in class III patient group

	Women		Men	
	Left	Right	Left	Right
MPDS				
Mean	1.388	1.320	1.740	1.808
SD	0.540	0.344	0.118	0.198
N	5	5	5	5
Non-MPDS				
Mean	1.100	1.012	1.252	1.484
SD	0.347	0.319	0.454	0.489
N	5	5	5	5

RESULTS

An equal number of patients from each category was selected for proper analysis of the complex number of variables. A comparison of right and left disclusion time among the nine MPDS patients who were arbitrarily eliminated and the 20 remaining was done to satisfy the question of inadvertent elimination of problem-related patients to achieve equality of sample size. The findings showed no significant differences in mean disclusion time. Although the number of patients eliminated was relatively small, my opinion is that inclusion of the data on these nine patients would not have altered the statistical outcomes.

In addition, the smallest cell-sample size within a given subgroup dictated the ultimate number of patients in each cell. For example, the first five men and the first five women in each jaw classification were arbitrarily selected for the comparison of class I, II, and III disclusion times, even though some categories had more patients, for example nine women and 11 men in class I. Five patients were selected from each class I category because in the class II and III samples there were categories with only five patients.

Table VIII. Analysis of right and left disclusion times (in seconds) for men and women, MPDS and non-MPDS, open occlusion patients only

Source	*df*	Mean square	F	*P*
Patient type	1	0.0302	0.12	0.7351
Gender	1	0.1464	0.57	0.4598
Type × gender	1	0.0000	0.00	0.9951
Error (between)	16	0.2552		
Side	1	0.0397	0.40	0.5380
Side × type	1	0.0017	0.02	0.8983
Side × gender	1	0.0029	0.03	0.8673
Side × type × gender	1	0.0504	0.50	0.4883
Error (within)	16	0.1002		

Table IX. Summary of descriptive statistics for right and left disclusion time (in seconds) in open occlusion patient group

	Women		Men	
	Left	Right	Left	Right
MPDS				
Mean	1.700	1.864	1.908	1.896
SD	0.390	0.533	0.561	0.307
N	5	5	5	5
Non-MPDS				
Mean	1.728	1.724	1.796	1.900
SD	0.464	0.529	0.195	0.204
N	5	5	5	5

MPDS versus non-MPDS patients

Differences in length of disclusion time (seconds) among MPDS patients and non-MPDS patients were determined by a three-factorial mixed-design ANOVA (Table II).

The principle conclusion from this analysis was that the mean disclusion time for the MPDS patient group was sig-

Table X. Analysis of right and left disclusion times (in seconds) for men and women, MPDS and non-MPDS patients who had previous orthodontic treatment

Source	*df*	Mean square	F	*P*
Patient type	1	7.0623	24.11	0.0000
Gender	1	0.0663	0.23	0.6379
Type × gender	1	0.1661	0.57	0.4578
Error (between)	28	0.2929		
Side	1	0.0233	0.36	0.5598
Side × type	1	0.0105	0.16	0.6916
Side × gender	1	0.0011	0.02	0.8998
Side × type × gender	1	0.0008	0.01	0.9151
Error (within)	28	0.0654		

Table XI. Summary of descriptive statistics for right and left disclusion time (in seconds) in patients who had previous orthodontic treatment

	Women		Men	
	Left	Right	Left	Right
MPDS				
Mean	1.578	1.550	1.525	1.528
SD	0.421	0.509	0.263	0.443
N	8	8	8	8
Non-MPDS				
Mean	0.830	0.765	0.995	0.932
SD	0.392	0.304	0.396	0.574
N	8	8	8	8

Table XII. Analysis of right and left disclusion times (in seconds) in orthodontic and nonorthodontic, men and women, MPDS patients only

Source	*df*	Mean square	F	*P*
Group	1	0.0044	0.011	0.9098
Gender	1	0.0375	0.11	0.7407
Group × gender	1	0.1182	0.35	0.5579
Error (between)	28	0.3359		
Side	1	0.1216	0.71	0.4074
Side × group	1	0.0892	0.52	0.4772
Side × gender	1	0.3039	1.77	0.1944
Side × group × gender	1	0.2413	1.40	0.2461
Error (within)	28	0.1719		

Table XIII. Summary of descriptive statistics for right and left disclusion time (in seconds) in orthodontic and nonorthodontic MPDS patients

	Women		Men	
	Left	Right	Left	Right
Orthodontic				
Mean	1.578	1.550	1.525	1.528
SD	0.421	0.509	0.263	0.443
N	8	8	8	8
Nonorthodontic				
Mean	1.672	1.250	1.546	1.645
SD	0.506	0.432	0.778	0.529
N	8	8	8	8

nificantly longer than that for the non-MPDS group. The mean disclusion time was 1.513 seconds for MPDS patients and 1.118 seconds for non-MPDS patients (p 0.0004).

The absence of significant interaction effects with patient type (MPDS, non-MPDS) indicated that the difference between patient types did not vary significantly with gender or right or left excursions (Table III).

Jaw classification

Differences in disclusion-time length among the three Angle jaw classifications was determined with a four-factorial mixed design ANOVA (Table IV).

The results indicated that mean disclusion times among the three Angle classification groups were significantly different as were the means between MPDS and non-MPDS patients.

Multiple comparisons among the three classification groups by t-test procedures based on appropriate mean-square error and degrees of freedom (df) from the ANOVA table were done, where error 1 = 0.3014, df = 48. The mean disclusion time (in seconds) simple effects comparison for class I was 1.133; class II, 1.698; class III, 1.388. For the groups analyzed with two-tailed probability, I versus II was < 0.001; I versus III was < 0.05 and > 0.02; and for II versus III, $p < 0.01$ and > 0.001. Examination of the individual means for jaw classification revealed that the class II occlusal relationship had the longest mean disclusion time and the class I occlusal relationship had the shortest mean disclusion time. Further comparisons between MPDS and non-MPDS groups were redundant because the analysis had already shown that disclusion time between these two groups was significantly different.

Examination of the means of MPDS patients and non-MPDS patients among the three jaw classifications revealed that MPDS patients had significantly longer mean disclusion time. The mean disclusion time for MPDS patients was 1.565 seconds; for non-MPDS patients it was 1.247 seconds. The probability was not statistically significant (p 0.0027).

The absence of significant interaction effects with jaw classification or patient types (MPDS, non-MPDS) may indicate that the differences among class and/or patient type did not vary with either gender or right/left mandibular excursions.

Because of the extremely small sample size in the experimental model, conclusions drawn from the ANOVA that relate to nonsignificant interaction comparisons have a serious power deficiency, insofar as nonsignificance may be a function of inadequate sample size.

Open occlusion patients

Disclusion time for patients with an open occlusion were determined with a three-factorial mixed-design ANOVA. Analysis of these data produced no statistically significant differences in disclusion time between MPDS patients and non-MPDS patients and there were no interaction effects with gender or right/left mandibular excursions. The sample size was small and may present a power deficiency in regard to nonsignificance (Tables VIII and IX).

Orthodontic MPDS patients versus orthodontic non-MPDS patients

A three-factorial mixed-design ANOVA was used to compare disclusion times of orthodontic MPDS patients with those of orthodontic non-MPDS patients (Tables X and XI). The principle conclusions from this analysis were that the mean disclusion time for the MPDS patient group was significantly longer than that of the non-MPDS patients. The mean disclusion time was 1.545 seconds for MPDS patients and 0.881 seconds for non-MPDS patients (p 0.000).

The absence of significant interaction effects with jaw classification or patient types (MPDS, non-MPDS) may indicate that the differences among class and/or patient type did not vary with either gender or right/left mandibular excursions.

Orthodontic patients versus nonorthodontic patients

Disclusion times for orthodontic MPDS patients and nonorthodontic MPDS patients (MPDS patients who had no previous orthodontic therapy) were determined by use of a three-factorial mixed-design ANOVA (Tables XII and XIII). The results indicated that for the MPDS group there were no significant differences in disclusion time between patients who had orthodontic treatment and those who had not, and there were no interaction effects with gender or right/left mandibular excursions.

DISCUSSION

In all but two parameters (open occlusion patients and orthodontic patients versus nonorthodontic patients), the comparisons of disclusion times between MPDS patients and nonpatients revealed that the MPDS patients had significantly longer mean disclusion times than those of the non-MPDS patients. This evidence suggests that lengthy disclusion time may be of diagnostic importance in the evaluation of potentially different etiologies for the chronic MPDS patient.

In the comparison of orthodontic MPDS patients with patients who had not had previous orthodontic therapy, there were no significant differences between the respective means (Table IX). This finding suggests that whether a patient has had previous orthodontic therapy does not influence longer or shorter disclusion times. These patients, with or without orthodontic treatment, had the symptoms associated with chronic MPDS.

Regardless of Angle's classification, MPDS patients had longer disclusion times than those of the non-MPDS patients. In addition, there were significant differences in disclusion time between the three jaw classifications (Table V). The longest mean disclusion time was seen in the class II patients (1.698 ± 0.53 seconds), then the class III patients (1.388 ± 0.44 seconds), and the class I patients with the shortest mean disclusion time (1.133 ± 0.44 seconds). This finding demonstrated that the occlusal relationship with the best anterior guidance capability had the shortest disclusion time. This is probably because anterior tooth contact occurs earlier in mandibular excursion if the anterior teeth approximate each other or are already in contact when a mandibular excursive movement begins.

This finding may explain why the patients with open-occlusion had long mean disclusion times (Table VI). These patients, like the class II patients, lacked anterior tooth contact, which predisposed them to extended posterior tooth contact during mandibular excursions. The anatomic separation of the anterior teeth caused a lack of anterior guidance capability. Therefore, posterior disclusion was not efficient during mandibular excursions and resulted in a lengthy disclusion time. The class III patients' mean disclusion time was significantly shorter than that of the class II patients. This was most likely because of better anterior guidance capability in the class III patients; there may have been some incisor and/or canine contact between the arches at the beginning of an excursive movement.

Anterior guidance capability may be established by orthodontic alignment or eliminated from the occlusion by an open occlusion or class II occlusal scheme. It is noted that the mean for the orthodontically treated patients (patients 1.545 ± 0.43 seconds, nonpatients 0.881 ± 0.42 seconds) indicated that tooth movement alone does not establish immediate posterior disclusion (≤0.5 seconds). Even the class I patients (patients and nonpatients combined) had a longer mean disclusion time (1.133 ± 0.44 seconds) than should have been established if immediate posterior disclusion was the desired occlusal scheme.

In all of the populations analyzed, the mean disclusion times were longer than 0.5 seconds. In a previous study, it was reported that if disclusion time is lengthy (> 0.5 seconds), elevated levels of contractile muscle activity are present in the masseter and temporal muscles.[1] The finding that "normal" (non-MPDS) patients of all jaw classifications in this study had lengthy disclusion times (with potentially elevated levels of muscle activity) suggests that a threshold mechanism of symptomatic muscle dysfunction may be in place for MPDS patients. The clinical

symptoms may not appear unless the patient's individual threshold for the buildup of toxic by-products from excessive muscle contractions is exceeded. This could eventually occur naturally in an occlusal scheme, with lengthy disclusion time building large amounts of muscle contractions. Or, an individual patient's threshold could be lowered by external factors such as jaw trauma. Previously unseen symptoms may become clinically apparent with the threshold lowered.

Despite previous evidence that women are more likely to experience chronic MPDS symptoms,[8] there was no significant difference between men and women in disclusion time (men 1.4024 ± 0.54 seconds, women 1.2285 ± 0.57 seconds). That women seem to suffer MPDS symptoms more often than men do may be explained by the threshold mechanism hypothesis that the male threshold is probably higher than that of the female.

It appears that the MPDS patient group in this study had longer disclusion time than did the non-MPDS patients. However, it is not known why the non-MPDS patients, who had lengthy disclusion times as in class II, class III, open occlusion, and class I patients with poor anterior guidance capability, did not have clinical symptoms. Kerstein and Wright[1] have shown that contractile muscle activity is proportional to disclusion time whereby lengthy disclusion time elevates levels of contractions in the masseter and temporalis muscles. From this determination, occlusal schemes with poor anterior guidance capability should be predisposed to high levels of muscle activity and clinical symptoms. In this study, numerous patients with extended disclusion times did not exhibit symptoms, which supports the theory that a threshold mechanism of clinical symptom appearance from extended disclusion time may exist.

Okeson[9] describes the phenomenon of physiologic tolerance as a variable in each patient's ability to adapt to malocclusions and functional disturbances. Each person has a unique ability to adapt to imperfections within his or her physiology. This adaptive capability may vary widely from patient to patient. The clinical appearance of MPDS symptoms may be an indication that an individual's physiologic tolerance to the etiologic variables has been exceeded, which would be the nature of the disclusion time/muscle activity threshold mechanism. With lengthy disclusion time present in an occlusal scheme, excessive muscle contraction occurs over time and leads to the buildup of toxic muscle contraction by-products (namely lactic acid) within the muscle fibers. In a given day, a patient's level of toxins will exceed the muscle's ability to metabolize these toxic substances. This would then initiate an ischemic state followed by the clinical appearance of MPDS symptoms. Continued daily, weekly, monthly, and yearly, lengthy occlusal compressions of the posterior teeth and their periodontal ligaments, as a result of lengthy disclusion time, would perpetuate the high levels of muscle contractions and establish an ongoing state of chronic ischemia and muscle dysfunction.

A lack of clinical symptoms despite the presence of lengthy disclusion time in an individual occlusal scheme would indicate that either the patient's physiologic tolerance has not yet been exceeded or the other potential contributory etiologic factors, such as temporomandibular joint derangements, degenerative joint disease, and/or other musculoskeletal disorders, are not present or, if present, have not exceeded the patient's physiologic tolerance.

Although compelling conclusions cannot be drawn from a patient sample this size, certain trends can be ascertained from this study. A larger population should be studied to verify the observed trends.

SUMMARY

The right and left disclusion times of 40 patients with chronic MPDS were compared with those of 40 non-MPDS patients. The types of disclusion time comparisons analyzed were MPDS versus non-MPDS patients, jaw classification (class I, II, or III), patients with open occlusion, orthodontic patients, and nonorthodontic patients versus orthodontic patients.

All groups of MPDS patients studied had statistically longer disclusion times than the non-MPDS patients studied, with the exception of the patients with open occlusion and the orthodontic versus nonorthodontic MPDS patients.

CONCLUSIONS

1. Combined right and left disclusion times were greater in MPDS patients than in non-MPDS patients.
2. Class II patients had the longest mean disclusion times of the three Angle classifications. Class III had the second longest mean disclusion times and class I had the shortest.
3. Patients with open occlusion had the longest mean disclusion time of all of the patient groups analyzed. A lack of potential anterior guidance capability during excursive mandibular movements predisposed the open occlusion and class II patients to lengthy posterior disclusion time.
4. MPDS patients who previously had orthodontic therapy had longer mean disclusion times than those of the non-MPDS patients. There was no difference in mean disclusion times between patients who had previous orthodontic therapy and patients who had not had previous orthodontic therapy.
5. A threshold mechanism for each patient may be present that, if exceeded, allows the symptoms of chronic MPDS to become clinically apparent. Numerous "normal" patient groups had longer disclusion times than those previously reported to be neuromuscularly healthy (less than 0.5 seconds). The non-MPDS patients had shorter disclusion times than those of their patient counterparts in all but two comparisons (patients with open occlusion and orthodontic versus nonorthodontic patients).
6. Lengthy disclusion time may be a diagnostic factor in

the total clinical assessment of a patient who experiences the symptoms associated with chronic MPDS. Pretreatment disclusion time analysis may allow the dentist to ascertain whether potential elevated levels of contractile muscle activity in the masseter and temporalis muscles are being completely or partially activated by the existing occlusal scheme.

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