Kinesiographic and electromyographic assessment of the effects of occlusal adjustment therapy on craniomandibular disorders by a double-blind method

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Fifty-one patients with craniomandibular disorders were divided into two groups. One group underwent mock occlusal adjustment, the other was treated with adjustments to remove significant slides and nonworking-side interferences. Both groups received identical counseling. Kinesiographic and electromyographic assessment showed no significant difference between the two groups. (J PROSTHET DENT 1993;69:85-92.)

Occlusal adjustment therapy or coronoplasty, a selective coronal tooth modification,[1] is an established method for the treatment of craniomandibular disorders. However, placebo effects can influence all treatments applied to these disorders and since the results of the occlusal adjustment are irreversible, careful application of the method is mandatory.[1, 2] There are few controlled studies to assess the effectiveness of occlusal adjustment for treatment of craniomandibular disorders, and to date, no report has appeared using a combined clinical and electronic assessment.

The complexity of analyzing spatial craniomandibular relationships has intrigued researchers for the past 125 years.[3] Although differences of opinion may exist among proponents of various forms of prosthodontic therapy, there appears to be general agreement that understanding, measuring, and reproducing mandibular movement may be a valuable aid in the diagnosis and management of stomatognathic system disorders. The K6 diagnostic system (Version 4.1 GS 1988, Myo-Tronics, Inc., Seattle, Wash.) is one example of a computerized device designed for the specific purpose of recording mandibular movements by tracking a magnet secured to the lower incisors.[4] According to the manufacturer, the K6 system is a reliable and accurate diagnostic instrument that may be used for patients suffering from craniomandibular disorders. Although Cooper and Lucente[5] believe that the capacity of making objective measurements of mandibular functions, together with associated muscle activity, has revolutionized the management of craniomandibular disorders, not all investigators agree.[6, 7] Feine et al.[6] and Mohl et al.[7] have criticized the analyzing system of the mandibular kinesiograph (MKG), particularly the diagnostic criteria for the classification of normal and abnormal movement patterns of the mandible and the absence of controlled studies to substantiate these criteria.

In their review article on surface electromyography, Lund and Widmer[8] conclude that "... a well-designed clinical investigation includes the random assignment of subjects to test groups, appropriate controls, the use of placebos and double-blind evaluation techniques, and appropriate statistical analyses."

The aims of this study were (1) to evaluate the effects of occlusal adjustment on the signs and symptoms of craniomandibular disorders by using specific clinical observations, electromyographic (EMG) and kinesiograph recordings, and a double blind method, and (2) to assess the usefulness of electronic devices in the diagnosis and treatment of craniomandibular disorders.

As previously reported,[9] improvements in the signs and symptoms of the patients obtained by real or mock adjustments after the first treatment session demonstrated a marked placebo effect. Furthermore there was difficulty in completely eliminating centric relation–centric occlusion slides and nonworking interferences in one treatment session.

PATIENTS AND METHODS

During a period of approximately 2 years, 51 patients with craniomandibular disturbances, 44 women and 7 men, 15 to 52 years of age (mean age 31.4 years), referred to the Department of Prosthetic Dentistry and the Department of Oral and Maxillofacial Surgery for evaluation of the disturbances, were invited to participate in the investigation.

The criteria for the selection of the patients and double-blind procedures were previously reported.[9] Patients were randomized into two groups: those on whom mock occlusal adjustment was made at the first treatment session (23 patients, 19 women and four men in the age range of 18 to 50 years; mean age 30.9 years; SD 8.1 years), and those on whom some real occlusal adjustment was made at the first treatment session (28 patients, 25 women and 3 men, in the age range of 15 to 52 years; mean age 31.8 years; SD 11.4 years).

Apart from the first visit, only one clinician was present at any session. The methods of this double-blind study and

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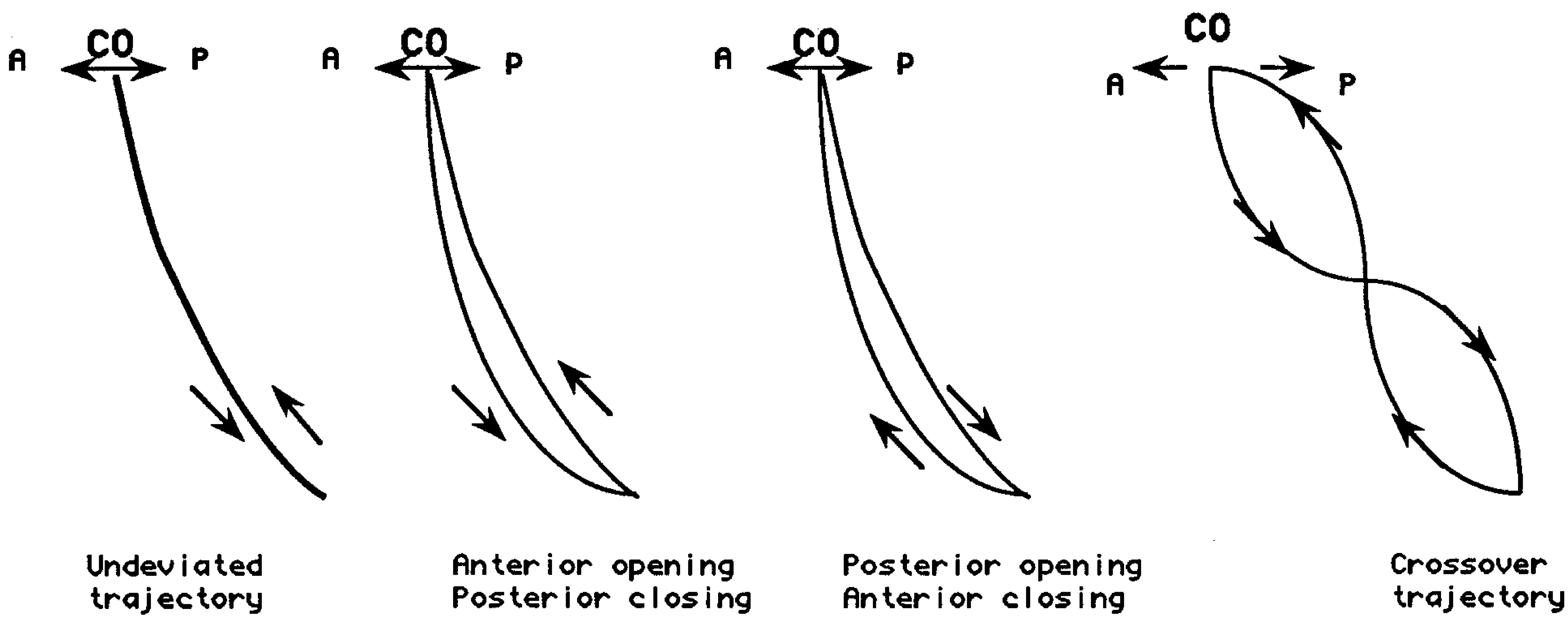

Fig. 1. Patterns of opening and closing in the sagittal plane. *A*, anteriorly; *P*, posteriorly.

the clinical examination procedures were described in a previous article.[9] The adjustments of occlusion were performed directly in the mouth to reproduce common clinical techniques. All evaluation sessions were conducted by the same examiner (PT) 10 days after each treatment session undertaken by another clinician (HP). The number of patients' visits ranged from four to 11. Treatment time ranged from 1 month to 6 months. Follow-up time was from 12 to 26 months.

Patients were evaluated before and after each treatment session by (1) assisting them in completing a special anamnestic questionnaire and a psychological test,[9] (2) conducting a full clinical examination of the craniomandibular system,[9] and (3) obtaining EMG and MKG recordings.

Electromyographic recordings

Equipment. The EMG recordings were made with the model EM2 bioelectric processor (Myo-Tronics, Inc.), a four-channel surface EMG intended primarily for use as a single system for clinical monitoring of as many as eight different muscles.[10] The EM2 system can interface with the model K6 diagnostic system (MKG), allowing simultaneous display and storage of the kinesiographic and EMG data. The EMG data can also be displayed and stored as either raw (filtered, qualitative) or processed (rectified, filtered, quantitative) data. Two basic objectives are sought with the EMG equipment: the determination of the degree of relaxation of a particular muscle or muscle group at rest and the precise measurement of the levels of electrical activity from several muscles during clenching.

Procedure. Each patient sat upright in a dental chair with both feet on a foot rest and hands resting on the lap. Activity from four muscle sites, the anterior temporalis and masseter bilaterally, was recorded. Electrodes were positioned over the belly of the muscle parallel to its long axis so that the outer edge of electrode tape corresponded with the outer edge of the muscle.[11] Specific guides were used to reposition the electrodes at the same position for each subsequent recording session. The amount of electrical activity generated by these muscles at rest was quantified. The patient was asked to relax, to keep the teeth apart, and to sit quietly and try to refrain from swallowing. The EM2 records were made continuously for 40 seconds. Resting values ranged from 0 to 25.5 μV. (The EM2 system averages and records muscle activity every five seconds and prints the final average at the end of the 40-second interval.) The amount of activity generated when the muscles contracted was then recorded. The patient was asked to relax the jaw and then to clench the teeth as hard as possible and relax again. These data were recorded as one second of instantaneous EMG activity with the K6 system only. The peak and the average values and the firing order of the muscles during the one second burst was monitored.

Kinesiographic recordings

Equipment. The kinesiographic (MKG) recordings were made with the Model K6 diagnostic system, (Myotronics, Inc.), which is an integrated computerized system designed specifically for monitoring mandibular movements in three dimensions. On the basis of past experience,[12] in the hands of a skilled operator, the MKG-K6 could be used for the measurement of craniomandibular relations, provided that the distortions and shortcomings of the instrument were well understood.

Procedure. A small slip of acrylic resin was placed to hold the magnet close to the labial surface of the lower incisors. Impressions of each patient's mouth were made and diagnostic casts were mounted in centric occlusion (CO) on a Dentatus ARL articulator (A B Dentatus, Hägersten, Sweden) a facebow record. The tracking magnet was then mounted with its long axis and upper surface horizontal and parallel with the intercondylar axis and the locating groove facing left.

The patient was seated upright in the dental chair, with both feet on the foot rest, hands resting on the lap, and with the Frankfurt plane parallel with the floor. The magnet slip

Table I. Mean values of the rest activity of the elevator muscles in the placebo and real treatment group before and after first treatment session

	Rest activity (μV/sec)			
	A Session*		B Session*	
Elevator muscles	Placebo	Real	Placebo	Real
Left anterior temporalis	9.06	7.94	5.67	7.19
Left masseter	6.70	6.64	5.84	5.95
Right masseter	5.42	8.22	7.44	5.29
Right anterior temporalis	5.03	7.68	5.10	5.34

A, Before treatment; *B*, first session treatment.
*None of the differences between the groups were significant.

was checked in the patient's mouth to ensure that it was free of interference from the surrounding structures. If it was unstable, it was cemented with resin (Peripheral Seal, De Trey, Dentsply, York, Pa.). The eyeglass frame with the sensor array was placed on the patient and was firmly tightened by means of the adjustable strap behind the head. The sensor array was first aligned visually with the patient's teeth together and head upright. Visual alignment was followed by automatic alignment. Three preset K-6 programs (scans)[5] to record the jaw movements in the following order were chosen.

Scan 1. The patient was asked to place the teeth together, then to open the mouth as wide as possible, and then to close (maximum opening and closing). Values from the analyzing program of the computer were as follows: (1) maximum vertical opening from centric occlusion (CO) (MVO), (2) maximum anterior-posterior movement (sagittal plane) from CO (MA-P), and (3) maximum lateral deviation, right and left (frontal plane) (MDR, MDL).

Four patterns of opening and closing in the sagittal plane (Fig. 1) were observed: (1) an undeviated trajectory, (2) an anterior opening and posterior closing, (3) a posterior opening and anterior closing, and (4) a crossover trajectory.

Scan 2. The patient was asked to open and close the mouth normally and then wide and fast for assessment of the velocity of the jaw. This test yielded the following values: maximum (MV) and average (AV) velocities during normal opening and normal closing and the maximum velocity at terminal tooth contact (terminal velocity). This was the mandibular velocity immediately before initial tooth contact (TV).

The MV and AV of the jaw during the fast and wide opening and closing together with the velocity at terminal tooth contact (TV) were recorded. From these tracings it was determined whether the movements of the jaw were smooth or erratic and irregular (dyskinesia) and whether there was clicking.

Scan 3. The patient was asked to relax, to clench the teeth, and then tap them together. This program provided information about the vertical interocclusal space (free way space) together with anterior, posterior, and lateral movements of the jaw from rest position to CO. From this test, the following values were recorded: (1) the interocclusal space during rest position (free-way space) (FS); (2) the anterior-posterior movement (slide) of the jaw from rest position to CO (SA-P); and (3) the lateral movements (right or left slide) of the jaw from rest to CO (SR, SL).

The Mann-Whitney U test was used to compare the EMG and MKG recordings and some clinical data between the two groups. The chi-squared test and Fisher's exact test in case of small numbers were used to compare qualitative variables between the groups. Associations between the EMG and MKG recordings and some of the clinical variables were investigated by by use of one-way analysis of variance (ANOVA).

RESULTS

Electromyographic results

Test 1. *Rest (postural) activity.* The initial pretreatment electromyographic examination showed that the real treatment and placebo groups did not differ significantly in relation to the rest (postural) activity of the elevator muscles. Similarly, after the first treatment session (placebo or real), the posttreatment EMG examination showed no significant difference between the two groups. The mean values of the average rest activity of the elevator muscles for both groups are shown in Table I.

There was a reduction of the rest activity in both groups after the first treatment for most of the muscles, with the exception of a slight increase of the rest activity of the right masseter and right anterior temporalis in the placebo group. The rest activity of the elevator muscles of the real treatment group was decreased after the first occlusal adjustment by 0.69 to 2.93 μV. In the placebo group after the first treatment session with mock adjustment, the rest activity of only the left side elevator muscles decreased by 0.86 to 3.39 μV. The rest activity of the right side elevator muscles in this group increased by 0.07 to 2.02 μV. The anterior temporal muscles activity of the real group decreased by 0.75 to 2.34 μV, as did the masseter muscles by 0.69 to 2.93 μV. In the placebo group, 36.4% to 54.5% presented

Table II. Changes in the EMG rest activity of the elevator muscles in both groups between A and B session

	Rest activity (μV/sec)											
	Placebo group						Real group					
	1 Unchanged		2 Better		3 Worse		1 Unchanged		2 Better		3 Worse	
Elevator muscles	n	%	n	%	n	%	n	%	n	%	n	%
Left anterior temporalis	4	18.2	12	54.5	6	27.3	5	17.8	13	46.4	10	35.8
Left masseter	4	18.2	12	54.5	6	27.3	7	25.0	10	35.7	11	39.3
Right masseter	4	18.2	3	40.9	9	40.9	5	17.8	15	53.6	8	28.6
Right anterior temporalis	3	13.6	8	36.4	11	50.0	3	10.8	16	57.1	9	32.1

A, Before treatment; *B*, first session treatment; *n*, number of patients.

Table III. Mean values of the maximum and average electromyographic activity of the elevator muscles during clench between placebo and real treatment group before and after the first treatment session

	Clench activity (μV/sec)			
	A Session*		B Session*	
Elevator muscles	Placebo	Real	Placebo	Real
Left anterior temporalis	174.1 (107.9)	155.5 (98.9)	180.5 (112.7)	164.0 (100.5)
Left masseter	141.7 (90.1)	133.8 (82.2)	141.1 (86.3)	137.1 (85.6)
Right masseter	168.1 (101.4)	145.5 (88.6)	160.1 (98.8)	138.4 (84.6)
Right anterior temporalis	202.5 (124.1)	176.1 (109.4)	191.1 (122.8)	174.6 (112.2)

A, Before treatment; *B*, first treatment session.
*None of the differences between the groups were significant. Values in parentheses are the means of the average activity.

an improvement (decrease) in the rest activity of the elevator muscles. This improvement was seen in 35.6% to 57.1% of the real treatment group (Table II).

Test 2. *Elevator muscle activity during clench.* No significant differences existed in the maximum or average values of the elevator muscle activities during clenching (maximum biting) for both groups before or after the first session treatment. The mean values of the maximum and average activity of the elevator muscles during clench (1 second) are shown in Table III. No noticeable changes in "clench" activity of the muscles were found in either group before and after the first treatment session.

Kinesiographic results

Scan 1. *Maximum opening and closing.* No significant differences existed between the two groups before and after the first treatment session with the following measurements (Table IV): maximum vertical opening, maximum anterior posterior movements in the sagittal plane, and maximum deviation right or left in the frontal plane. The trajectory patterns in the sagittal plane during the maximum opening and closing were the following.

For the placebo group before any treatment, eight patients presented a crossover pattern, nine a posterior opening and anterior closing, three an anterior opening and posterior closing, and three an undeviated trajectory.

After the first session with mock adjustment, 13 patients presented a crossover pattern, three a posterior opening and anterior closing, four an anterior opening and posterior closing, and two an undeviated trajectory.

For the real treatment group before any treatment, seven patients presented a crossover pattern, 11 a posterior opening and anterior closing, five an anterior opening and posterior closing, and five an undeviated trajectory.

After the first session with real adjustments, five patients presented a crossover pattern, 10 a posterior opening and anterior closing, nine an anterior opening and posterior closing, and three an undeviated trajectory. It therefore appears that the trajectory patterns in the sagittal plane during the maximum opening and closing were unaffected by the type of treatment.

Scan 2. *Velocities of the jaw during normal and fast opening and closing movements.* The mean values of the maximum and average velocities of the jaw during normal and very fast opening and closing movements and the terminal velocities for both groups are shown in Table V. None of the differences between the groups before and after the first treatment session were significant.

The pattern of these movements showed that of the placebo group before any treatment, 11 patients presented clicking in the normal opening and closing, 12 dyskinesia in the normal opening and seven in the normal closing. After the first treatment session 11 patients presented clicking and 12 dyskinesia in the normal opening, and eight

Table IV. Measurements in the three planes of the maximum opening and closing movements between placebo and real treatment group before and after the first treatment session

	Measurements (mm)			
	A Session*		B Session*	
Scan 1 (Open-close)	Placebo	Real	Placebo	Real
Maximum vertical opening	31.87	32.57	34.13	34.87
Maximum anterior-posterior movement, sagittal plane	9.87	10.07	10.29	9.87
Maximum deviation left, frontal plane	4.56	4.03	3.48	3.09
Maximum deviation right, frontal plane	2.93	2.39	3.77	3.52

A, Before treatment; *B*, first session treatment.
*None of the differences between the groups were significant.

Table V. Mean values of the maximum, average, and terminal velocities of the jaw during normal and fast open-close movements, between the placebo and real treatment group before and after the first session of treatment

	Velocities of the jaw (mm/sec)			
	*A Session		*B Session	
Scan 2	Placebo	Real	Placebo	Real
Maximum velocity during normal opening	104.7	113.3	99.7	112.1
Average velocity during normal opening	56.2	59.1	56.1	59.9
Maximum velocity during fast opening	254.3	221.7	263.4	247.7
Average velocity during fast closing	124.1	106.5	126.6	121.6
Maximum velocity during normal closing	111.5	116.5	133.0	136.9
Average velocity during normal closing	54.1	60.8	67.2	67.1
Terminal velocity during normal closing	20.8	22.9	22.7	19.5
Maximum velocity during fast closing	267.5	299.8	284.3	298.5
Average velocity during fast closing	136.1	151.6	144.1	141.4
Terminal velocity during fast closing	66.1	71.3	77.1	60.5

A, Before treatment; *B*, first session treatment.
*None of the differences between the two groups were significant.

clicking and six dyskinesia respectively in the normal closing.

Of the real treatment group before treatment, 13 patients had clicking in the normal opening and closing, 11 dyskinesia in the normal opening and nine in the closing phase. After the first treatment session, 10 patients presented clicking and 16 dyskinesia in the normal opening, and nine and seven respectively in the normal closing.

Scan 3. *Vertical interocclusal space (interocclusal distance) and movements of the jaw in sagittal and frontal plane from rest position to centric occlusion.* No significant differences were found between the two groups before or after the first treatment session. The mean values of the interocclusal distance, anterior-posterior movement, and lateral movements for both groups and before and after the first treatment session are shown in Table VI.

Influence of clinical variables

In the pretreatment examination of the 51 patients, on the EMG and the MKG recordings, no significant associations were found between most of the occlusal disturbances such as the nonworking-side interferences and the EMG activity of the elevator muscles during rest or clenching. Significant associations were found ($p < 0.05$) only between the unilateral premature contacts in CR with the rest activity of the anterior temporalis muscles, and between the posterior interferences in protrusion with the rest activity of the right anterior temporalis muscle. The pattern of the opening and closing movements in the sagittal plane seemed unaffected by the symptoms.

DISCUSSION

EMG assessment before and after the first session of real or mock adjustments showed no significant difference between the groups. However, centric relation–centric occlusion slides and nonworking-side interferences were completely eliminated in approximately half of patients in the real treatment group at the first treatment session. These complications were discussed in the previous report.[9] There was a reduction of rest activity in both groups after the first treatment for most of the muscles, with the exception of a slight increase of rest activity of the right masseter and right anterior temporalis muscles in the placebo group.

Table VI. Mean values of freeway space and movements of the jaw in sagittal and frontal plane from rest position to centric occlusion (CO), between placebo and real treatment group before and after the first treatment session

	Measurements (mm)			
	A Session*		B Session*	
Scan 3 (From rest to CO)	Placebo	Real	Placebo	Real
Freeway space	2.67 (0.2-12)	1.53 (0.1-3.4)	2.62 (0.1-9.2)	2.16 (0.4-7.2)
Anterior-posterior movement	0.71	0.47	0.71	0.64
Left lateral movement	0.21	0.22	0.27	0.28
Right lateral movement	0.07	0.04	0.1	0.06

A, Before treatment; *B*, first treatment session.
*None of the differences between the two groups were significant. Values in parentheses are the minimum and maximum.

In a longitudinal study by Sheikholeslam et al.,[13] the reduction levels of the postural activity of the anterior temporal and masseter muscles in patients with functional disorders after occlusal adjustment treatment ranged from 1.5 to 2 μV and from 0.5 to 1 μV respectively. Ramfjord[14, 15] reported a dramatic improvement in the muscle function pattern in patients with interferences after occlusal adjustment. These studies have been critiqued in two recent comprehensive reviews of electromyography.[8, 16] Lack of quantification of the EMG response and absence of a control group probably make the conclusions untenable. The EMG assessment of the rest activity when other kinds of treatment were applied, such as a psychophysiologic program of therapy and biofeedback training,[17] showed that the EMG activity decreased significantly in the masseters of the treatment-success and treatment-failure groups, alike compared with a normal control group. The unsuccessful group also showed a significant decrease after therapy in the anterior temporal activity compared with the control group. Kardachi et al.,[18] in a comparison pilot study of biofeedback and occlusal adjustment on bruxism, showed that the effect of occlusal adjustment on nocturnal EMG was varied and unpredictable. Biofeedback resulted in a 70% reduction but returned to the original level after treatment. A "mock adjustment," a "random feedback," and a nonbruxing group, which presented no substantial changes in the activity, were used as controls in this study.

In this report, no significant differences were found in the maximum or average values of the elevator muscles' activities during clenching (maximum biting) in either group before or after the first treatment session. In addition, no noticeable changes in clench activity of the muscles was found before and after the first treatment session in either group. Consequently, real and mock adjustments seem to have similar effects on the EMG activity of the elevators muscles during clenching. Sheikholeslam et al.[13] found that the average activity during maximal bite in the intercuspal position in patients with such disorders was the same after the treatment as before. Ingervall and Carlsson[19] found similar results in their study of masticatory muscle activity during maximal bite before and after elimination of balancing side occlusal interferences.

All EMG resting activity values before and after treatment for both groups in this study were higher, compared with the normal range given by the manufacturer's manual.[11] Unfortunately, the data collected by the manufacturer was presented so that comparative conclusions cannot be drawn.[8, 20] It should be noted that factors such as age, sex, weight, skeletal type, oral habits, occlusal scheme, head posture during EMG registrations, and electrode type and position can affect the reliability of this diagnostic instrument.[21-24]

In this study no significant associations were found between the nonworking-side interferences and EMG activity of the elevator muscles during rest or clenching. Significant associations were found only between the unilateral premature contacts in CR and the rest activity of the anterior temporalis muscles, and between the posterior interferences in protrusion and the rest activity of the right anterior temporalis muscle.

Kinesiographic assessment during the maximum opening and closing movements showed that mock and real occlusal adjustment had nearly the same effects on the maximum vertical, anterior-posterior, and deviation movements of the jaw in the frontal and sagittal planes after the first session of treatment. There were no significant differences in these measurements between the two groups before treatment.

Because this is the first attempt of a double-blind kinesiographic evaluation of the effects of occlusal adjustment on the mandibular movements, there is no direct comparison of the results. Creagh and Smith,[25] using a specially constructed jaw-recording device, found that the mean maximum lateral deviation of 12 patients was significantly reduced after treatment that involved occlusal splint therapy with instruction in isokinetic exercises. In a recent study, Nielsen et al.[26] demonstrated that splint therapy significantly altered the mandibular movement pattern by increasing the length and extent of an initially reduced laterotrusion and by straightening the protrusive excursion. In this study, the pattern of anterior-posterior displacement of the jaw in the sagittal plane during maximum opening and closing movements did not seem to be related to the symptoms and the type of applied treatment, mock or real.

Our kinesiographic assessment of the maximum and average velocities of the jaw during normal and fast opening and closing movements showed that mock and real occlusal adjustment after the first session produced similar effects. Because the program of the K6 system used in the present study evaluates the velocity of the jaw during opening and closing movements and not during mastication, it is impossible to compare these results with others studies. Ow et al.[27] using an LED system showed that the mean values for the maximum speeds of the jaw during mastication in six women with craniomandibular disorders were 96.8 mm/second before and 105.4 mm/second after the treatment. Mongini et al.[28] studied 86 patients with craniomandibular disorders and found that the mean velocities of the jaw during mastication were 41.74 to 68.69 mm/second for opening the mouth and 33.18 to 61.51 mm/second for closing. The maximum mandibular speeds during mastication for normal subjects are in the range from 64 to 135 mm/second.[29] Howell[30] studied 97 young adults by using the K5 kinesiograph and found that the maximum speed of movements during the opening phase of the masticatory cycle varied from 58 to 272 mm/second for the individuals and the maximum closing velocity was 69 to 256 mm/second.

Results of this study also demonstrated no significant differences in the vertical interocclusal space between the two groups before treatment and after the application of the mock or real adjustment. Slides of the jaw in sagittal and frontal plane from rest position of the jaw to centric occlusion were similarly unaffected. Cooper et al.[31] using the MKG, showed that of 476 patients before treatment, 24% presented healthy free-way space and 76% presented unhealthy interocclusal distance. According to these researchers, healthy was defined as 0.75 to 2 mm and unhealthy from <0.75 mm or >2 mm (average ranges). In this study, all 125 patients treated long-term had healthy interocclusal space.

There are several difficulties in clinical trials of this nature, including an instability of jaw movements and the associated electrical muscle activity as well as shortcomings of the K6 system. This device was designed primarily for use in clinical practice instead of research, for which the recording time is relatively short. Similarly, the software appears to be limited in the recording options and flexibility provided. Furthermore, it might be desirable to provide the operator with the option of checking and readjusting the accuracy of the K6 system before every single experiment. This system appears to the initial steps of its development. Further work is required to provide refinements and improvement that would make the machine a valuable scientific tool.

CONCLUSIONS

1. The EMG and MKG measurements mirrored clinical assessment in that no significant differences were noted between the real treatment and placebo group after the first session of treatment.
2. The recorded rest muscle activity of both groups decreased after the mock and real adjustments.
3. Kinesiographic assessment showed that mock and real adjustments had similar effects on opening and closing movements. Differences in maximum vertical opening and in lateral deviations were insignificant. In addition, the maximum average velocities during normal fast opening and closing movements showed that mock and real adjustments had almost the same effect. The results of this study also demonstrated no significant differences between the two groups before treatment and after the application of the mock or real adjustment in the vertical interocclusal space.
4. The instability of the jaw movements and the associated electrical muscles activity, together with shortcomings of the K6 system, demonstrated the complications of clinical trials.

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