Masseter and Temporalis Excursive Hyperactivity Decreased by Measured Anterior Guidance Development


ABSTRACT: The purpose of this study was to determine if a statistically significant reduction in muscle activity (p<0.05) occurs when prolonged disclusion time (>0.4 sec/excursion) is shortened to <0.4 sec/excursion with the Immediate Complete Anterior Guidance Development (ICAGD) enameloplasty. Forty-five symptomatic, fully informed subjects (29 female, 16 male) had their right and left disclusion times recorded with T-Scan III, while simultaneously, the bilateral masseter and anterior temporalis muscle activity was recorded electromyographically with BioEMG III (n=180 muscles). This recording was done twice, once pretreatment and again posttreatment (same day) after undergoing the ICAGD enameloplasty on the same day without changing electrodes. The Student’s paired t-test was utilized to detect any significant change in the muscle activity levels between the pre- and posttreatment lateral excursive muscle contractions. Highly significant reductions were found in all four muscles’ activities after shortening the pretreatment prolonged disclusion time to less than 0.4 seconds (p<0.0014); after Bonferroni correction (p<0.006). When properly performed, such that the posttreatment disclusion time is <0.4 sec/excursion, the ICAGD enameloplasty predictably reduces excursive muscle activity levels in the bilateral anterior temporals and masseter muscles. Excursive muscle hyperactivity can be a source of lactic acid accumulation, muscular ischemia, and chronic myalgic temporomandibular joint dysfunction (TMD) symptoms. The ICAGD enameloplasty significantly reduces excursive muscle contractions after completion of the first ICAGD treatment session.

Excursive masseter and temporalis muscle activity levels can be one source of muscular symptomology in chronic temporomandibular joint dysfunction (TMD) patients. Some chronic patients experience minimal symptom resolution despite continuously wearing orthotic devices, using medications frequently, and employing adjunctive treatments, including cognitive behavioral counseling.

A previously published mechanism for the etiology of masticatory muscle excursive hyperactivity theorized that elevated levels of excursive muscle activity are instigated from prolonged excursive molar tooth contacts resulting in prolonged periodontal ligament (PDL) compressions of the periodontal ligament mechanoreceptors.1 The afferent PDL mechanoreceptors communicate into the mesencephalic nucleus of the brain, but pass through it without synapsing there, to further reach the trigeminal motor nucleus. Here, the periodontal ligament mechanoreceptors make their first synapse with the efferent fibers that travel back to the masticatory musculature,2 which then instruct the masticatory muscles to contract above their baseline, resultant from the periodontal ligament

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compressions. The proposed published mechanism suggested that the longer the excursive interferences are in time, the longer time the periodontal ligaments are compressed, and the longer time the masticatory muscles are activated to contract.\textsuperscript{1} Prolonged excursive tooth contact durations were first measured with the T-Scan I instrument (Tekscan Inc., S. Boston, MA)\textsuperscript{3} and termed \textit{Posterior Disclusion Time}.\textsuperscript{4} It was defined as the elapsed time required for a patient to exit from complete intercuspation, and move right, left, or forward, to disclude all of the posterior teeth until only canines and/or incisors were in contact.\textsuperscript{4} An occlusal adjustment study performed with T-Scan I revealed that when long disclusion time (1.39 sec./excursion) was corrected to short disclusion time (0.41 sec./excursion), the subjects’ elevated pretreatment masseter and temporalis contraction levels were significantly reduced to near the resting state (p<0.05).\textsuperscript{4} The occlusal adjustment procedure employed to shorten the pretreatment long disclusion time was named \textit{Immediate Complete Anterior Guidance Development} (ICAGD).\textsuperscript{4,5} It was (and still is today) an alternative enameloplasty to traditional occlusal equilibration,\textsuperscript{6} as its primary focus is excursive movements. ICAGD is a measurement driven, computer-guided occlusal adjustment procedure that has specific numerical occlusal time and occlusal force endpoints to objectively quantify post-treatment results.\textsuperscript{1,5} Traditional occlusal equilibration is an unmeasured occlusal adjustment procedure that focuses on the location of centric relation with bimanual manipulation. Its results are subjectively determined thru operator assessment of occlusal feel, sounds, paper mark size, and color depth, patient subjective occlusal feel, and/or clench testing.\textsuperscript{6} Modern published occlusal adjustment studies about equilibration on teeth are limited within the literature.\textsuperscript{7} In addition, reviews of the literature regarding unmeasured occlusal adjustment procedures performed on teeth report that occlusal adjustment is unpredictable in resolving TMD symptoms.\textsuperscript{1-12} ICAGD performed on teeth has been studied repeatedly since 1991. Findings indicate that ICAGD produces a lasting muscle relaxation response.\textsuperscript{13,15} In a published controlled occlusal adjustment study, ICAGD was found to reduce myalgic symptoms in the treated group as compared to a control group that underwent \textit{mock ICAGD}. Symptom resolution in the treated group resolved without a pretreatment splint or medication use.\textsuperscript{13} In 2006, two separate dental computer technologies were synchronized together: T-Scan II (Tekscan Inc., S. Boston, MA) for Windows (Windows is a trademark of Microsoft Corp., Seattle, WA) and BioEMG II (Bioresearch, Inc., Milwaukee, WI) for Windows.\textsuperscript{16} Together, they simultaneously record changing electromyographic levels and occlusal contact force data with high definition.\textsuperscript{17} In a study of 62 patients with orofacial myalgia who underwent ICAGD, these synchronized technologies showed that one month after ICAGD, the maximum voluntary clench contractile muscle strength of the masseter and temporalis muscles had significantly increased (p<0.001).\textsuperscript{18} Additionally, observable excursive function muscle contraction reductions have been reported to occur during the first ICAGD treatment session.\textsuperscript{16,19} The purpose of this study was to detect any same day of treatment, statistically significant electromyographic changes in the bilateral masseter and temporalis muscles, resulting from the ICAGD enameloplasty.

**Materials and Methods**

The subject group consisted of 45 chronic myalgic TMD patients who were part of a private practice population seeking treatment for chronic TMD symptoms. Twenty-nine were female and 16 were male with a mean age 43.2±11.92 years. All subjects were informed as to the ICAGD procedure to be undertaken, and gave their full consent. After a comprehensive medical history and clinical examination, those selected for treatment exhibited primarily orofacial myalgic symptoms. Joint Vibration Analysis (BioJVA, BioResearch, Inc., Milwaukee, WI) was employed to verify that any temporomandibular joint conditions present were minimal and were of a soft tissue displacement type.

**Inclusion criteria** were one or more of the following clinical conditions:

- Ongoing head, neck and facial pain such as headaches around the eyes, midface and temples
- Jaw tension, chewing fatigue
- Previous or ongoing unsuccessful splint use
- A history of chronic pain medication ingestion
- Mildly painful joints without internal derangement
- Frequent clenching and bruxism habits often with associated morning jaw stiffness
- Demonstration of one or two disclusion times greater than 0.4 seconds
- Anterior teeth that coupled or nearly coupled

**Exclusion criteria** were the following:

- Patients whose anterior teeth did not couple or nearly couple
- Patients with primary internal derangements, such as locking, complete TMJ dislocation, or painful disc displacement with or without reduction
- Avascular necrosis of the condyle with loss of condylar height resulting in asymmetry
- A present systemic disease or tumor of the temporomo-
mandibular joint.
• A range of motion limited to less than 35 mm
• Bilateral disclusion times less than 0.4 seconds
• Patients who, after receiving full ICAGD disclosure, did not consent to treatment

Prior to instituting ICAGD, the patient’s skin was cleansed with isopropyl alcohol. Self-adhesive bipolar EMG electrodes were placed bilaterally over the bodies of the superficial masseter and the anterior temporalis muscles, with the axis of each electrode parallel to the direction of the muscle fibers. All EMG data was recorded through a BioEMG III amplifier and the BioPAK computer program (BioResearch, Inc., Milwaukee, WI). The EMG sampling rate used was 1000 samples/second and data was converted from analog to digital values with 16 bits of resolution. Since all of the treatments were done in one session, the electrode placements were not altered between the pre- and posttreatment recording. \((n=180\) muscles analyzed).

For each subject, the T-Scan III (Figure 1) (Tekscan Inc., S Boston, MA) recorded pre- and posttreatment disclusion time duration measurements of the right and left excursive movements. The recordings were made in Turbo Mode, where the sensor was scanned in 0.003 second increments to maximize the timing resolution of the recorded occlusal contact data. Simultaneously with the T-Scan III data acquisition, electromyographic contractile activity levels of the bilateral masseter and anterior temporalis muscles were recorded. All the recorded occlusal contact and EMG data were time-stamped and, because the purpose of this study was to detect any change in the activities of masseter and anterior temporalis muscles resultant from ICAGD treatment, each treated subject acted as his/her own control.

According to the manufacturers pre-recording recommendations for obtaining useful T-Scan III data for intraoral clinical treatment, a generation IV high definition sensor (HD recording sensor, Tekscan Inc., S Boston, MA) was positioned solidly within the midline facial central incisal embrasure where the sensor was crimped around the occlusal surfaces with four test subject maximum-intercuspications. The crimping has been shown to improve the repeatability of the recorded occlusal force data. Also, a proper recording Sensitivity Level was selected that matched the responsiveness of the HD sensor to each subject’s individual occlusal force potential.

With the conditioned sensor ready for data acquisition, a pretreatment recording was activated where first, each subject made a firm voluntary complete closure into maximum intercuspation where they held their teeth firmly together for 1-3 seconds. After that, each subject commenced a left excursion from that completely intercuspidated position until only their canines and/or central or lateral incisors were in contact on the left side. The same process was repeated for the right lateral excursion. This method of recording the right and left excursive disclusion time has been shown previously to produce statistically reliable numerical values representative of a given subject’s individual disclusion times. Protrusive excursions were not measured, analyzed, or treated.

Sample pretreatment right and left excursions with their associated EMG data, can be seen in Figures 2 and 3. The pretreatment excursive disclusion time length can

Figure 1
A. The T-Scan III and the BioPak EMG record occlusal contacts and masticatory function simultaneously. B. The set up shown on a patient
be found within the data window of the pretreatment Force vs. Time Graph (bottom left pane of Figures 2 and 3, and enlarged for clarity in Figures 4 and 5). At line “A” intercuspation begins. This is where the subject makes first tooth contact, after which, more teeth successively occlude until the subject reaches static intercuspa-
tion. At “A,” the black total force line rises sharply indicating increasing total occlusal force as more teeth occlude and more muscle fibers are activated from the increasing tooth contact. In the EMG data (right half of each figure; top and bottom panes), the increasing tooth contact elicits an increase, both in the muscle fibers’ rate

Figure 2
Sample subject pretreatment left excursive T-Scan III disclusion time data synchronized with BioEMG muscle activity level data. Excursive hyperactivity is present after line “C” until line “D.”

Figure 3
Sample subject pretreatment right excursive T-Scan III disclusion time data synchronized with BioEMG muscle activity level data. Excursive hyperactivity is present after line “C” until line “D.”
of firing and in the recruitment of additional motor units from the four measured muscles. At line “B,” complete intercuspation occurs where all teeth that can potentially contact have finished intercuspat ing. Here, the occlusal forces no longer change as the patient commences statically holding their teeth firmly together in centric occlusion. This static hold is visible within the Force vs. Time Graph where the black total force line, the red (right anterior quadrant), dark green (left anterior quadrant), light green, (left posterior quadrant), and the purple (right posterior quadrant) lines all turn horizontal. After line ”B” through to line ”C,” the subject holds their teeth firmly

**Figure 4**
Force vs. Time Graph of pretreatment left excursive disclusion time data. Pretreatment left disclusion time = 1.18 seconds.

**Figure 5**
Force vs. Time Graph of pretreatment right excursive disclusion time data. Pretreatment right disclusion time = 3.136 seconds.
intercusped where all colored lines stay horizontal. Within the EMG data, the “B-C” period is where the muscles are clenched while keeping the teeth firmly intercusped and a large number of periodontal ligament compressions are occurring. In Figure 2, the black total force line declines somewhat, as the subject demonstrates a slow loss of total force between “B” and “C.” The subject cannot maintain a constant level of intercusped force due to muscle fatigue resultant from trying to firmly intercuspate.

At line “C,” a mandibular excursion is commenced and all five colored lines change direction. The black total force line sharply drops as the subject reduces the force between her teeth to begin the excursion. At “C,” the four colored quadrant lines diverge from the horizontal to reflect increasing or decreasing relative force changes within their respective quadrants as the excursion progresses towards line “D.” Line “D” marks the first time-moment when only anterior tooth contact occurs within the excursion (Figure 2), or when the recording of the excursion ends and no time-moment exists where only anterior contact occurs (Figure 3). In Figure 2 after C, there is a marked rise in the light green posterior left quadrant line, and a slow decline of the purple right posterior quadrant line, indicating there is a prolonged period of bilateral posterior tooth contacts occurring during the excursion. The purple line eventually drops to 0% force at 3.764 seconds, followed by the light green line dropping to 0% at 3.938 seconds, while late in the excursion, the dark green anterior left quadrant line rises to the top of the graph to equal 100% total force at line “D.” In Figure 3 after C, there is a marked rise in the purple posterior right quadrant line that declines and travels across the graph without ever reaching 0% force, indicating there is a non-ending and very prolonged period of posterior right quadrant tooth engagement that occurs during the excursion. The light green posterior left quadrant line initially drops (but not to 0%) in force after “C,” but due to the increase of forces on the balancing side during the excursion, the light green line then rises, crests, and finally drops to 0% at 3.756 seconds. Simultaneously in Figure 3, the red anterior right line never rises to the top of the graph to equal 100% total force, but travels horizontally and parallel to the purple line below (purple line never reaches 0%), which indicates that the right anterior quadrant is not able to disclude the posterior teeth completely. In the EMG data after “C” is where the presence of excursive muscle hyperactivity can be detected in both Figures 2 and 3.

The disclusion time length is the elapsed time required to travel from line “C” to line “D.” In Figures 2 and 4 the time distance from C to D equals 1.18 seconds; in Figures 3 and 5, the time distance from C to D equals 3.136 seconds. Note that within the sample EMG data of Figures 2 and 3, just to the right of C until D, the working temporalis and the bilateral masseter muscles demonstrate muscle activity levels that are elevated well above resting state. These elevated firing patterns are resultant from the prolonged posterior tooth engagement occurring within the right and left excursion movements.

With the EMG electrodes left undisturbed in place upon the patient’s face, ICAGD was then performed as has been previously described and validated in studies and clinical reports. Once completed, posttreatment right and left excursion recordings were made (in the same fashion as pretreatment) to measure the muscle activity levels that occurred during the posttreatment excursion movements. Sample posttreatment ICAGD EMG data obtained from the same patient presented in Figures 2 and 3 can be seen in Figures 6 and 7 (right half of each figure; top and bottom panes). Just to the right of line “C,” when the posttreatment excursion commences, the working temporalis and the bilateral masseter muscles demonstrate large decreases in muscle activity when compared to the pretreatment C-D period (Figures 2 and 3). After ICAGD, the pretreatment left disclusion time was reduced from 1.18 seconds to 0.292 seconds, and the pretreatment right disclusion time was reduced from 3.136 seconds to 0.372 seconds. In Figures 6 and 7, after line “C,” both the light green posterior left quadrant line, and the purple posterior right quadrant line, quickly drop to 0% force indicating there no longer exists a prolonged period of posterior tooth engagement during either excursion. Also note that after line “C” in Figures 6 and 7, both the dark green anterior left quadrant line, and the red anterior right quadrant line rapidly rise to the top of the graph to equal 100% total force. This indicates that right and left anterior quadrant are now able to rapidly disclude the posterior teeth in less than the desired 0.4 seconds per excursion.

Statistical analysis of the EMG data was accomplished as follows: because the primary objective of ICAGD is to reduce the disclusion time below 0.40 seconds, each subject’s pretreatment and posttreatment EMG data were analyzed from the onset of the excursion (at “C”) out 0.512 seconds towards “D.” The means and standard deviations for each muscle’s activity before and after treatment were calculated out 0.512 seconds past “C” to insure that the pre- and posttreatment EMG comparison was made between the first 0.512 seconds of the long pretreatment disclusion time, with the same 0.512 seconds of the posttreatment shortened disclusion time. The Student’s paired t-test (alpha = 0.05) was first applied to each muscle separately, and then to all four muscles as
pre- and posttreatment groups. Finally, the Bonferroni correction was employed to reflect a more conservative estimate of the calculated p values. An additional Student’s t-test was done on a sample (16 subjects) of pre- and post-treatment resting EMG levels, to determine if treatment had a significant effect on changing resting EMG levels.

Results

Tables 1, 2 and 3 detail the pre- and posttreatment means and standard deviations of the studied excursive EMG levels. All three tables show that the means and standard deviations for each of the four muscles decreased.
### Table 1
Means and Standard Deviations in Microvolts for the Four Muscles During Right Excursions, Before and After Treatment. Student's Paired \( t \)-Test Indicated Significant Changes

<table>
<thead>
<tr>
<th>Muscles</th>
<th>Pre tx C + 0.512 seconds</th>
<th>Post tx C + 0.512 seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA-R-</td>
<td>52.8422</td>
<td>38.7914</td>
</tr>
<tr>
<td>TA-L-</td>
<td>17.3178</td>
<td>8.7743</td>
</tr>
<tr>
<td>MM-R-</td>
<td>33.3689</td>
<td>18.8286</td>
</tr>
<tr>
<td>MM-L-</td>
<td>43.8733</td>
<td>25.1857</td>
</tr>
</tbody>
</table>

| Means   | 52.8422                  | 38.7914                   |
| SD      | 33.4650                  | 20.8516                   |
| \( p = \) | 0.000000                | 0.000002                  |

### Table 2
Means and Standard Deviations in Microvolts for the Four Muscles During Left Excursions, Before and After Treatment. Student's Paired \( t \)-Test Indicated Significant Changes

<table>
<thead>
<tr>
<th>Muscles</th>
<th>Pre tx C + 0.512 seconds</th>
<th>Post tx C + 0.512 seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>TA-R-</td>
<td>19.3778</td>
<td>8.2083</td>
</tr>
<tr>
<td>TA-L-</td>
<td>60.2750</td>
<td>35.0722</td>
</tr>
<tr>
<td>MM-R-</td>
<td>38.3333</td>
<td>22.9556</td>
</tr>
<tr>
<td>MM-L-</td>
<td>33.5583</td>
<td>13.8500</td>
</tr>
</tbody>
</table>

| Means   | 19.3778                  | 8.2083                    |
| SD      | 23.4601                  | 6.8348                    |
| \( p = \) | 0.001324                | 0.005294                  |

### Table 3
Means, Standard Deviations (Microvolts), and Student's Paired \( t \)-Test for Complete Blocks of Right and Left Excursion Data. Student's Paired \( t \)-Test Indicated Significant Changes

#### Right excursions

<table>
<thead>
<tr>
<th>Whole dataset (all 4 muscles)</th>
<th>Pre tx</th>
<th>Post tx</th>
<th>( p = )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Means</td>
<td>36.80056</td>
<td>21.24389</td>
<td>2.35E-18</td>
</tr>
<tr>
<td>Standard deviations</td>
<td>29.84947</td>
<td>19.56958</td>
<td></td>
</tr>
</tbody>
</table>

#### Left excursions

<table>
<thead>
<tr>
<th>Whole dataset (all 4 muscles)</th>
<th>Pre tx</th>
<th>Post tx</th>
<th>( p = )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Means</td>
<td>37.88611</td>
<td>20.02153</td>
<td>8.25E-14</td>
</tr>
<tr>
<td>Standard deviations</td>
<td>35.59385</td>
<td>22.06200</td>
<td></td>
</tr>
</tbody>
</table>
after the ICAGD treatment. This confirms that, not only did the average amount of EMG activity decrease, but the variability of the EMG activity was also reduced. Applying the Student’s t-test to the individual muscle data showed that significant muscle activity reductions occurred in all four muscles posttreatment (p<0.0014). After Bonferroni correction, the significance level was p<0.006. When testing the data as complete muscle groups of pretreatment vs. posttreatment EMG activity, the Student’s paired t-test showed p<0.0000 for both left and right excursions. This indicates that the four muscles as a group demonstrated significantly decreased EMG levels.

Table 4 details the statistical analysis of the resting EMG before and after treatment of 16 subjects. Many subjects had either before treatment resting EMG data, or after treatment resting EMG data, but not both available for analysis. This was because in 29 subjects the measured muscles began contraction before the T-Scan/EMG started to record. The usable sample of pre- and posttreatment resting EMG activity was compared using a Student’s paired t-test, as well. For the left excursions p=0.6340 and for the right excursions p=0.7696, which indicated no significant differences in either case. This resting EMG data demonstrated no evidence of resting muscle hyperactivity within these subjects either before or after treatment (where hyperactivity is generally considered to be >2.0 microvolts).

### Discussion

These results are not in conflict with the findings of previous studies involving ICAGD and disclusion time reduction.4,13,14,18 The results indicate that performing ICAGD and creating short disclusion time reduces pretreatment elevated levels of excursive masticatory muscle function. The very low p values suggest that hyperactive excursive muscle activity levels, when they exist, can be predictably reduced by using the ICAGD enameloplasty procedure.

The T-Scan III data revealed that the dominant tooth contacts which caused elevated excursive muscle activity levels were observed in the subject population on the working side. This observation suggests that working side group function should be avoided as an occlusal design in favor of one that is anterior guided with short disclusion time. Working side group function appears to create increased excursive muscle activity levels. Regardless of the nature of the occlusal surface (restored or natural), the results of this study suggest that reduced levels of excursive muscle activity can be achieved if working side group function is avoided and measurable immediate posterior disclusion is employed (disclusion time ≤0.4 seconds per excursion).

ICAGD shortens posterior disclusion time to ≤0.4 seconds per excursion, which establishes an occlusal scheme where the posterior teeth compress each other and their
respective periodontal ligaments during excursive movements, for far less time than during an untreated occlusion. This shortens the contraction time of the masseter and temporalis muscles and limits the addition of excess contractions to the baseline contractions required to make functional movements. A posttreatment physiologic muscular activity reduction is thus established through the precise altering of the timing of functional excursive contacts that can occur on opposing contacting posterior tooth occlusal surfaces. This study provides an explanation as to why chronic myalgic TMD symptomatology has been reported to be successfully lessened when ICAGD is properly performed.4,13-16,19

The EMG data in Figures 6 and 7 illustrates the marked reduction in excursive muscle activity that ICAGD offers the hyperactive patient. In the pretreatment condition depicted in Figures 2 and 3, after line “C” there is a high degree of muscle hyperfunction, which has been minimized in Figures 6 and 7 immediately after “C.” In place of the pretreatment exaggerated hyperfunction, there is a visibly marked decline in the bulk of the hyperfunction during the excursive movements. This physiologic change occurred in a single treatment appointment because the marked lessening of the disclusion time immediately reduces the duration of periodontal ligament compressions. It is important to note that in Figures 6 and 7, both working temporalis muscles maintain a degree of slightly elevated muscle activity, despite the disclusion time being very short. This lack of total muscle shut down could be due to some residual muscle memory resultant from the subject’s long-standing condition. Or, more likely, it is possible that the remaining visible muscle activity is the muscles’ functional baseline level required to contract so as to move the mandible through its excursive movements.

ICAGD is an occlusal adjustment procedure that requires measurement and calculation to insure the occlusal changes have been correctly accomplished. Objective occlusal force and time data guides treatment, and all subjective occlusal assessments are eliminated.5,13,14,18,19 In light of the results of this study, other previously published occlusal adjustment studies, and clinical reports involving ICAGD, the unmeasured nature of noncomputer-guided occlusal adjustment procedures has likely been partially responsible for the reported lack of effectiveness of occlusal adjustment therapy in the treatment of temporomandibular disorders.9-12

It has often been suggested that treating occlusal dysfunction beginning in centric occlusion may be problematic, if the condyle is located in a distally displaced position, or the disc condyle relationship is not healthy. For exactly these concerns, all subjects in this study underwent joint vibration analysis to verify that any included subject, who demonstrated pretreatment temporomandibular joint conditions, was presenting for study analysis with solely reducing, soft tissue displacement type, derangements.

Despite the widespread belief that treating occlusal problems in centric occlusion (MIP) may be problematic, since 1991, every published study on disclusion time reduction performed with ICAGD has been accomplished from MIP. Moreover, every study has reported marked and rapid symptom resolution, without worsening of the temporomandibular joint dysfunction. It is important to note that there is no published research that proves conclusively whether centric relation, centric occlusion, or a neuromuscularly obtained jaw position is best for the human condition. It is prudent that one ensure a healthy disc-condyle orientation before treating, but it has never been proven in a scientific study that a human functions better in one specific jaw relation over another. Presently, no consensus exists regarding which position is best, nor that perceived positional correctness ensures myalgic symptom resolution. The results of this study confirm the findings of previous studies, that physiologic muscular improvements can be predictably and rapidly obtained working from centric occlusion. As such, the perpetuated belief that MIP is a problematic jaw relation to work from in the absence of significant internal derangements, seems to be an unrealistic theory. ICAGD studies, both past and present, continue to refute the belief that centric occlusion is a problematic occlusal treatment position.

Despite the high degree of reported statistical significance of the muscle contraction level reductions (reflected in the calculated very low p values), there were a number of limitations present with the study design. First, an inclusion requirement was that each subject’s anterior teeth couple or nearly couple. Although this simplified rendering treatment to the study subjects, this requirement eliminated any potential subject whose anterior teeth were too far apart to use as guiding teeth. Thus, this treatment effect was only measured in Class I subjects. Potential extrapolations regarding muscle contraction reductions that ICAGD might offer the Class II patient, the moderate-to-severe open occlusion patient, and the severe Class III patient, should be avoided, since no EMG data from this study was obtained from these types of malocclusion patients. However, based upon the results obtained with subjects whose anterior teeth did couple, instituting any procedure that couples the canines in these noncontacting anterior tooth malocclusions to convert them into contacting guiding teeth (orthodontics, bonded canine risers, prosthetics, porcelain adhesion, etc.),
may offer myalgic patients who present with these other malocclusions the same significant muscle activity reductions. Once coupling is completed, these malocclusion patients could safely undergo the ICAGD enameloplasty.

A second limitation was that the subjects were their own controls. Because this study attempted to determine a measured treatment effect (changes in EMG levels from before and after ICAGD), using the subjects as their own controls was necessary. To compensate for this limitation, the Students paired t-test was employed. The paired t-test very effectively separates the variations between conditions within each muscle from the natural variations between different subjects. A further constraint was same-day recording of both the pre- and posttreatment EMG data. This was done to eliminate any variation from removing and replacing the EMG electrodes. The BioFLEX EMG electrodes used absorb moisture through the skin of the patient and maintain their impedance indefinitely.

A third study limitation was that one clinician only performed all the pre- and posttreatment EMG measurements and all of the ICAGD treatment. Despite the lack of additional treating clinicians, this study method was somewhat standardized because the single operator design reduced the potential inter-operator ICAGD treatment differences. Different clinicians would be expected to produce somewhat different results and not create precisely the same consistency of end results, subject after subject. This could potentially affect the EMG response to treatment. Therefore, it is important to state that these study results are unlikely to be representative of all outcomes by all clinicians because the outcome of the performed occlusal adjustment procedure is at least partially dependent on the skill of the clinician performing it.

A fourth limitation was that, although myalgic symptom resolution was orally reported to have occurred in the vast majority of treated subjects without any other treatment being rendered, no analysis of symptom response from treatment was performed. No pre- and posttreatment symptom data were gathered or tabulated in any standardized way for detailed reporting, because the focus of the study was to assess if the physiologic change that has been previously reported that disclosure time reduction creates within the masticatory musculature was a statistically significant change. Despite the lack of a standardized symptom reporting method being employed in this study, as has been observed in previous published disclosure time reduction studies and clinical reports, this present group of 45 studied subjects orally reported rapid (within 7-60 days posttreatment), and marked muscular symptom improvements: reduced facial pain, reduced temporal headaches, reduced earache, reduced use of pain and anti-inflammatory medications, reduced morning jaw pain without using splints or orthotics, reduced frequency of clicking and popping of the TM joints, improved chewing strength and duration, and improved sleeping comfort without using splints or orthotics.

A last possible study limitation is that protrusive excursions were not recorded, analyzed or treated. In every study protocol accomplished to date regarding ICAGD and disclosure time reduction, protrusive excursions have not been analyzed or treated. Despite the non-inclusion of protrusive excursive data, previously published results have suggested that excusive muscle hyperactivity is primarily a right and left excusive problem. An ICAGD technique article does recommend assessing protrusion in addition to the right and left movements (and treating protrusively if its disclosure time is prolonged). However, all previously published studies have shown consistent muscle physiology improvements and myalgic TMD symptom reductions without analyzing or treating protrusive disclosure time duration. Perhaps this is due to the fact that lateral excursions are far more prevalent than antero-posterior excursions during masticatory activity. This study attempted to follow the same clinical treatment protocol as those that preceded it, in order to compare these results against previously reported findings.

Conclusion

Forty-five symptomatic chronic myalgic TMD patients underwent pre- and post-ICAGD enameloplasty treatment measurements made of their right and left excusive disclosure times with simultaneously recorded electromyography of the bilateral masseter and anterior temporalis muscles. Posttreatment excusive EMG levels were significantly reduced from the ICAGD enameloplasty procedure. The results of this study indicate that when ICAGD is properly performed, such that the posttreatment excusive disclosure time is ≤0.40 seconds duration, significant muscle activity level reductions may be observed immediately upon completion of an initial treatment session.

References

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