

Evaluation of the Reproducibility of Rest Activity of the Anterior Temporal and Masseter Muscles in Asymptomatic and Symptomatic Temporomandibular Subjects

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There is a general assumption that temporomandibular disorders and the pain and tenderness of mastication muscles may be caused by hyperactivity. Five asymptomatic men, five asymptomatic women, and five women with temporomandibular disorders participated in this study. Multiple examinations were performed to provide information concerning the reproducibility of the rest electromyographic signals. No significant differences between groups were noted. This study supports the contention that the mean rest activity in women with pain and dysfunction is less than or equal to that of sex-matched controls.

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There is a general assumption that pain and tenderness of muscles of mastication and intracapsular temporomandibular disorders (TMD) may be caused by jaw closing muscle hyperactivity.¹⁻⁷ Lous et al⁸ have suggested that this phenomenon occurs in the anterior temporal muscle. They compared 39 patients with functional disorders of the masticatory system to 45 controls, and they showed that the masticatory muscle postural activity of patients was greater than that of controls. The patient and control groups were not matched by age and sex. The increase in postural activity was more pronounced in the anterior temporal muscle, with individual variations greater in patients than in controls. The increased activity was also correlated with tenderness on muscle palpation.

Dohrmann and Laskin⁹ also found more electromyographic (EMG) activity in TMD patients than in controls. In this study, experimental and control groups were not matched by age and gender.

Sheikholeslam et al¹⁰ demonstrated that the mean level and peak mean voltages during maximal occlusal force in the intercuspal position was significantly stronger in the controls than in the patients. Differences between the men and women were insignificant with respect to temporal and masseter muscles in patients. However, maximal activity of the men's masseters was stronger than the women's in control subjects. No significant differences were found with respect to age, but absolute values were less in the older patients. The number of opposing and missing teeth was not significantly different. The patients had less masticatory muscle activity than the controls.

Majewski and Gale¹¹ compared TMD patients with controls matched by age and sex and did not find significant differences in the

EMG activity of anterior temporal muscles. When increased activity has been found, bruxism is also usually present.^{6,12,13}

Møller¹⁴ has suggested that EMG activity with maximal clenching was less as the gonial angle increased. Similar findings were suggested by Ingervall and Thilander.¹⁵ Ahlgren¹⁶ found an association between a small gonial angle and high EMG activity of the masseter muscles during chewing. Ahlgren et al¹⁷ has also suggested that children with small gonial angles demonstrated higher resting EMG than those with large gonial angles.

The hypothesis of this study was that EMG rest activity is reproducible in asymptomatic subjects and symptomatic TMD patients. The null hypothesis was to be rejected if the repeated measures were not reproducible.

Materials and Methods

Five asymptomatic men aged 29 to 43 years (mean age 36.6 years), five asymptomatic women aged 31 to 37 years (mean age 34 years), and five symptomatic women experiencing TMD aged 11 to 32 years (mean age 24 years) were recorded three times in five separate sessions to study the reproducibility of rest EMG activity of the anterior temporal and masseter muscles.

The asymptomatic subjects were selected after successfully completing the following evaluations:

1. A TMD subjective questionnaire documenting the absence of jaw and ear pain, joint noise, pain on function, and jaw locking.
2. A clinical TMJ and dental examination as described by Roberts et al¹⁸ that did not reveal signs or symptoms usually associated with TMD or internal derangement (range of motion, deviation on opening, muscle palpation, and joint sounds).
3. An examination that did not reveal evidence of bruxism (TMD patients also showed no evidence of bruxism).
4. An examination that revealed an acceptable range of mandibular movements¹⁹ (maximal opening = 40 mm or more, lateral excursions = 10 mm or more).
5. A cephalometric analysis, which was performed on all individuals. Certain skeletal and dental parameters from the Downs analysis²⁰ were selected as criteria. Subjects displayed facial angle, mandibular plane angle, and interincisal angle characteristics within the Downs normal distribution of variation. This

incorporated individuals with an acceptable average mesocephalic facial pattern and profile, a Class I molar relationship, overjet not more than 3 mm, and overbite not more than 4 mm. There were no major mandibular shifts from centric relation to centric occlusion.

The asymptomatic subjects were part of an NIH study comparing magnetic resonance imaging (MRI) and arthrography of the TMJ. Symptomatic TMD patients were individuals presenting to the TMD clinic at Eastman Dental Center for evaluation. All TMD patients had localized jaw joint pain on one or both sides.

All control subjects and TMD patients had bilateral high resolution MR scans in the sagittal (closed and opened) and coronal (closed) planes to evaluate the TMJs for the presence or absence of internal derangement.^{21,22} The subjects were classified as being normal (no internal derangement) or having disc displacement with reduction (DDR) or disc displacement without reduction (DDN), and with or without degenerative joint disease (DDN/DJD) as described previously.²² All TMD patients had unilateral or bilateral internal derangements.

Hardware and Software

The EMG and jaw tracking apparatus has 12 channels with a system band width of 40 to 1,000 Hz (± 3 dB) and a gain of 5,000 (Bio-EGN, BioResearch, Milwaukee, WI). The input range was 0 to 1,400 μ V (peak to peak) without clipping. It has four channels of simultaneous EMG signal and four channels for graphic jaw tracking, with a sampling rate from 240 to 1,200 samples/second/channel. The total A to D conversion time was 1.5 microseconds/channel, and 9,600 samples/second were recorded. An IBM-compatible computer with a 20-MB hard drive, dual floppy drives, 640 kB RAM, a turbo processor, a high-resolution monochrome graphics board, and a graphics monitor was used for sample collection.

Bipolar reusable 5-mm surface electromyographic silver/silver chloride disc electrodes, separate adhesive pads, and separate conducting gel were used for signal collection (Med Associates, East Fairfield, VT).

Electrode Position and Placement

The skin overlying the right and left anterior temporal and masseter muscles, as well as the right

Table 1 Mean Rest Activity (\pm SD) and Intraclass Correlation Coefficients (ICC) for the Three Groups Studied

Muscle	Asymptomatic men		Asymptomatic women		Symptomatic women	
	Mean rest activity	ICC	Mean rest activity	ICC	Mean rest activity	ICC
Right temporal	4.4 \pm 1.0	.46	5.8 \pm 3.0	.56	5.9 \pm 0.9	-.13
Right masseter	2.5 \pm 0.5	.34	4.0 \pm 1.5	.42	3.1 \pm 0.4	-.05
Left masseter	3.3 \pm 1.5	.38	3.6 \pm 1.4	.37	2.8 \pm 0.6	.02
Left temporal	5.2 \pm 1.8	.76	5.6 \pm 1.3	-.02	4.7 \pm 1.3	.05

side of the neck (ground), was cleaned with alcohol to reduce skin impedance and enhance signal conductivity. To locate the areas for placement of the surface electrodes, the subject clenched so that the investigated muscle could be palpated. The most prominent part of the major muscle mass of the anterior temporal muscle was determined by palpating superior to the lateral part of the orbital rim, and it was marked with a felt pen. The superficial masseter muscle was palpated and marked. The long axis of each muscle was determined by palpation while the subject was clenching, and by knowledge of the anatomy of the muscle's origin and insertion. Electrodes were placed along the long axis of the muscle, with the centers of the electrodes 22 mm away from each other. Because reproducibility in relocating electrodes between recording sessions was critical,²³ a customized measurement template was constructed for each subject as described previously.²⁴

Recording Procedure

The subjects sat relaxed and upright in a straight-backed chair without head support and were instructed to look at the wall at eye level without head or body movements. Before the recording, the subjects were asked to place their teeth together, swallow, and let their jaws relax. Sampling was done for 10 seconds with the teeth apart. Three recordings were done with a 3-minute rest between samplings. The signals were amplified, filtered, and then sampled by the A-D converter and stored on disc. The computer program used a 32-point moving average for data sampling. Output data files were analyzed by another 286 computer using a customized software program written by one of the authors (WCM).

Statistical analysis consisted of the calculation of

intraclass correlation coefficients (ICCs) to evaluate reproducibility and analysis of variance (ANOVA) to assess differences between the three groups.

Results

The mean activity, standard deviation (SD), and ICC of each of the three groups studied are shown in Table 1. A significant difference was noted in the mean activity of the right masseter muscle. The asymptomatic and symptomatic women had higher mean values than the asymptomatic men. No other significant differences between groups were noted.

Table 1 lists the calculated values of the ICCs. The values were usually low to moderate for asymptomatic men and women, with the exception of the left temporal for asymptomatic women.

Discussion

Some studies have suggested that the mean resting activity of patients with TMD is elevated,^{1,7-9,12} while other studies have suggested no differences.^{11,13,25} In the present study, the asymptomatic women generally had lower mean activity than the symptomatic women. Mean values may suggest differences in two groups, but if they are not reproducible from session to session, these values have questionable value. Sherman¹³ suggested that differences are not present in TMD patients without bruxism. The activity was increased in subjects and TMD patients with bruxism. Lund et al²⁶ showed that there is a decreased activity at rest and an increase of activity with jaw opening. This study also supports their at-rest results.

The ICCs in the present study were very low, probably because the recordings were repeated five

times, which increased the variability. The lower correlation among the sessions may have reflected differences from one day to the next and/or methodologic problems with relocation of electrodes, even though a template was used. This suggests that rest EMGs taken over a treatment period would not be reliable to evaluate the effects of the treatment on muscle activity or pain. Burdette and Gale²⁷ suggested that multiple recordings of rest activity during a single session are satisfactory, but recordings from successive sessions demonstrated a decrease in reproducibility. Within the same session, correlation coefficients ranged from .7620 to .8884 for the masseter muscles and from .8686 to .9109 for the anterior temporal muscles. Between sessions (2 weeks later), correlation coefficient values ranged from .5645 to .6503 for the masseter muscle and from .3309 to .4844 for the anterior temporal muscle. Burdette and Gale²⁷ concluded that the lower correlation between sessions may reflect the problems of relocating the electrodes, particularly in the anterior temporal muscle. The present study did not report on reproducibility within the same session because the surface electrodes were not removed and then replaced in the sensor. The acceptable value for the left temporal muscle in the asymptomatic women cannot be explained. This may be a matter of chance, and caution should be taken when using an observation that appears to be isolated.

There has been a debate in the literature concerning the decrease in rest activity with an increase in vertical dimension.²⁸ Others have suggested that this decrease in activity results in a therapeutic effect (a decrease in TMJ pain and dysfunction). Burdette and Gale²⁹ suggested that a decrease in EMG activity of the masseter and temporal muscles did not correspond directly to treatment outcome. The current results suggest that the EMG values from multiple sessions are not reproducible, and values from successive sessions are questionable. This would make the correlation between decreased rest activity and a treatment effect difficult.

Conclusions

This study supports the contention that the mean rest activity in women with TMJ pain or dysfunction is less than or equal to that of sex-matched controls. The reproducibility between sessions is poor and needs to be evaluated further.

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Resumen

Evaluación de la reproducibilidad de la actividad de descanso de los músculos temporal anterior y masetero en personas con síntomas de desórdenes temporomandibulares y en personas asintomáticas

Existe una suposición general de que los desórdenes temporomandibulares y el dolor y sensibilidad de los músculos masticatorios puede ser causado por la hiperactividad. En este estudio participaron cinco hombres asintomáticos, cinco mujeres asintomáticas, y cinco mujeres con desórdenes temporomandibulares. Se realizaron exámenes múltiples para obtener información concierne a la reproducibilidad de las señales electromiográficas de descanso. No se observaron diferencias significativas entre los grupos. Este estudio soporta el argumento de que en promedio la actividad de descanso en mujeres con dolor y disfunción es menor o igual a aquella de los controles del mismo sexo.

Zusammenfassung

Evaluation der Reproduzierbarkeit der posturalen Aktivität im vorderen Anteil des M. Temporalis und im M. Masseter bei asymptomatischen und symptomatischen Patienten mit einer Myoarthropathie

Es herrscht die allgemeine Annahme, dass Myoarthropathien, sowie Schmerz und Empfindlichkeit der Kaumuskulatur durch Hyperaktivität verursacht werden können. Fünf asymptomatische Männer, fünf asymptomatische Frauen und fünf Frauen mit einer Myoarthropathie nahmen an dieser Studie teil. Es wurden mehrfache Untersuchungen ausgeführt um Informationen bezüglich der Reproduzierbarkeit der elektromyographischen posturalen Aktivität zu gewinnen. Es wurden keine signifikanten Unterschiede zwischen den Gruppen festgestellt. Diese Studie unterstützt die Behauptung, dass die durchschnittliche posturale Aktivität bei Frauen mit Schmerzen und Dysfunktion kleiner oder gleich derjenigen von geschlechtsentsprechenden Kontrollpersonen ist.