Revista Mexicana de Ortodoncia

Vol. 5, No. 4 • October-December 2017
pp e233–e239

ORIGINAL RESEARCH

Changes in electromyographical activity during different phases of orthodontic treatment: pilot study results

Cambios de la actividad electromiográfica durante las diferentes fases del tratamiento de ortodoncia: resultados de una prueba piloto

Claudia Ivonne Rodríguez Castañeda,*,§ Luis Pablo Cruz Hervert,*,||,¶ Eduardo Llamosas Hernández,§ David Elías Viñas,** Luis Antonio García Espinosa,¶ Nicolás Pacheco Guerrero,* Julio Morales González,* Fernando Ángeles Medina*

ABSTRACT

Electromyography is a useful tool in orthodontics to evaluate and monitor muscle activity for diagnosis and during treatment **Objectives:** The aim of this study was to determine changes in electric muscular activity during different phases of orthodontic treatment. **Material and methods:** We performed a cohort study and measured bilateral electromyographic activity (EMG) for 30 seconds in maximum intercuspation. EMG activity was measured monthly for 15 months during 4 phases in orthodontic treatment: preatreatment (P0), splint wear (P1); leveling and aligning (P2); space closure (P3); and finishing stage (P4). EMG was measured using a digital electromyograph developed by our group (hardware and software) to determine μV every 0.002 seconds. The root mean square (RMS) value was estimated as a mean value of EGM. Patients were treated at the Orthodontics Department and the Physiology Laboratory of UNAM during 2014-2016. We performed a descriptive, bivariate analysis and a random effects linear regression model for repeated measurements adjusted by age, gender, malocclusion and extractions. **Results:** Our pilot study included 10 patients (6 female and 4 male); mean age was 20 years. At baseline, maximum median EMG was recorded (median 239 μV, IQR 143 μV-561 μV), Multivariate analysis showed that EMG measurements decreased at P1 (regression coefficient [Coef]. -180.97; 95% CI -330.37, -31.56; p = 0.018), P3 (Coef. -168; 95% CI -332.36; -3.76; p = 0.045) and P4 (Coef. -184.21; 95% CI -326.91, -41.5; p = 0.011). **Conclusions:** EMG changes decreased randomly during orthodontic phases and not constantly as generally believed.

RESUMEN

La electromiografía es una herramienta útil en la ortodoncia para evaluar y monitorear la actividad muscular. **Objetivo:** Determinar los cambios en la actividad eléctrica muscular durante las diferentes fases del tratamiento ortodóntico. **Material y métodos:** Se realizó un estudio de cohorte y se midió la actividad electromiográfica bilateral (EMG) durante 30 segundos en máxima intercuspidación. Se realizaron 15 mediciones mensuales de la EMG durante cuatro fases en el tratamiento ortodóncico: basal (P0); uso de la férula (P1); nivelación y alineación (P2); cierre de espacios (P3); y la etapa de finalización (P4). Se usó un electromiógrafo (EMG) digital, desarrollado por nuestro grupo (hardware y software) para determinar μV cada 0.002 segundos y el valor medio cuadrático (RMS) fue estimado como un valor medio de EGM. Los pacientes fueron tratados en el Departamento de Ortodoncia y el Laboratorio de Fisiología en la UNAM durante 2014-2016. Se realizó un análisis descriptivo, un modelo de regresión lineal de efectos aleatorios para medidas repetidas ajustadas univariado y otro multivariado ajustado por variables confusoras. **Resultados:** Se incluyó a 10 pacientes, con edad promedio de 20.6 años. La medición basal de EMG fue de 239 μV (RIC 143-561). El modelo multivariado mostró una disminución de la EMG en P1 (coeficiente de regresión [Coef.] -180.97; IC 95% -330.37, -31.56; p = 0.018), P3 (Coef. -168; IC 95% -332.36; -3.76; p = 0.045) y P4 (Coef. -184.21; IC 95% -326.91, -41.5; p = 0.011), en comparación con la basal. **Conclusiones:** Los cambios EMG disminuyeron durante las fases ortodóncicas aleatoriamente durante las etapas de tratamiento no de manera constante como generalmente se asume.

Key words: Electromyographic, electric muscular activity, malocclusion, orthodontic treatment.
Palabras clave: Electromiografía, actividad eléctrica muscular, maloclusión, tratamiento de ortodoncia.

* Physiology Laboratory, DEPeI, Odontology Faculty, National Autonomous University of Mexico (UNAM).
§ Iztacala Faculty of Higher Studies (UNAM).
|| National Institute of Public Health.
¶ Department of Orthodontics, Autonomous University of Guadalajara
** Center of Advanced Research of the National Polytechnic Institute (CINVESTAV).

See related content at doi: http://dx.doi.org/10.1016/j.rmo.2018.01.015

INTRODUCTION

Electromyography (EMG), is the recording and study of the intrinsic electrical properties of the skeletal muscle. Electromyographic activity of the muscle is recorded via the use of electrodes that are placed on the skin, one in the origin and the other in the insertion of the muscle.[1-3] Although Dubois-Raymond developed electromyography in 1849, the applications in orthodontics are rare, even when the muscular component is of paramount importance for the diagnosis, planning and treatment of malocclusions.[4,5] One of the first specific applications was described by Jenkelson through the concept of miocentric position, which unlike the concepts of maximum occlusion and centric relation highlights the importance of muscular activity to achieve an adequate relationship of the occlusal, muscular and bony components.[6,7] However, in comparison with other study topics in the area of orthodontics there are few studies on applied electromyography. It is true however that there are some indexes or classifications to identify the presence of temporomandibular disorders or the presence of myofascial pain, for example, the Helkimo index or the pain map among others.[8] Most of these methods are subjective because they depend on the training of the clinician to evaluate and properly record the degree of alteration. As a result, these indices do not represent the best alternative to study muscle activity and muscle activity changes throughout the different phases of the treatment.[9] The use of electromyography, can represent a more objective method to evaluate muscle activity at the time of diagnosis, subsequent to the use of occlusal splints, prior to orthodontic treatment and the behavior of the electromyographic activity through the different phases of orthodontic treatment.

Together, the Physiology Laboratory of the Division of Post-Graduate Studies and Research (DEPeI) of the Faculty of Dentistry at the National Autonomous University of Mexico (UNAM) and the working group of the CINVESTAV Bioelectronics Laboratory of the National Polytechnic Institute (IPN) developed a device for recording electromyographic activity and a software for the analysis and interpretation of the information of the electromyographic activity.

In clinical practice the orthodontist assumes that there is an adaptation of the activity of the muscles of mastication, however it is unknown whether this represents an increase or decrease in muscle activity.[10] The aim of this study was to compare the synchronous electromyographic activity of each of the masseters at maximum intercuspation prior to orthodontic treatment, subsequent to the use of a occlusal splint and during different phases of orthodontic treatment.

MATERIAL AND METHODS

A pilot study was developed using a methodology of prospective cohort study to compare changes in the muscle activity of the masseter muscles during the different phases of orthodontic treatment with regard to the basal measurement.

The study was carried out in the Department of Orthodontics of the Iztacala Faculty of Higher Studies (FES-Iztacala) of the National Autonomous University of Mexico (UNAM) and the electromyographic measurements were performed in the Physiology Laboratory of the Division of Post-Graduate Studies and Research (DEPeI) of the Faculty of Dentistry of the UNAM. The period for patient recruitment was between January and March of 2015 and the follow-up evaluation of the last patient was conducted in February 2017.

The inclusion criteria were: 1) patients in an age range between 15 and 30 years, 2) patients accepted for treatment in the Department of Orthodontics of the FES-Iztacala, 3) without prior treatment of orthodontics or orthopedics, 4) patients without previous extractions, 5) patients with no systemic anomalies. Exclusion criteria were: 1) presence of severe myofascial pain, 2) previous diagnosis of temporomandibular disorder (TMD), 3) presence of any craniofacial syndrome, 4) reduced mouth opening (less than 15 mm). Elimination criteria were: 1) patients who declined participation in the study for any reason or circumstance, 2) patients who reported severe myofascial pain, 3) or presented reduced mouth opening (less than 15 mm), 4) abandonment or suspension of orthodontic treatment.

The selection of the sample was by convenience. Appointments for treatment and clinical evaluation of orthodontic treatment were performed at least once a month, while electromyographic evaluation was performed between one and three months. For each individual 15 measurements were considered throughout the treatment, one at baseline and 14 during treatment.

The dependent variable was the mean quadratic value or RMS (root mean square), and represents the average of the square values of the electromyographic activity. The RMS has only positive values ranging between zero and infinity, where zero represents a null activity and the higher the RMS value the higher will be the average of the electromyographic activity of the masseter muscle. The characteristics of the