Annals of Stomatology

Original Article

ELECTROMYOGRAPHIC ANALYSIS OF PATIENTS DURING ORTHODONTIC TREATMENT WITH F22 ALIGNER

A. Fantauzzo and G. Kussini

Postgraduate School of Orthodontics, University of Ferrara, Ferrara, Italy

Correspondence to:
A. Fantauzzo, DDS
Postgraduate School of Orthodontics,
University of Ferrara,
Via Luigi Borsari 46,
Ferrara 44121, Italy.
e-mail: alessandro_fantauzzi@yahoo.it

ABSTRACT

The aim of this reaerch paper is to investigate the electromyographic behavior of the elevator, masseter and temporal muscles, during the orthodontic treatment with aligners (F22). The subjects were 8 healty adult patients between 20-40 years of age. EMG carried out at the beginning of the therapy (T0) ad after each month (T1,T2,T3) with and without aligners (F22). In the statistical analysis, for each measure, a repeated measures ANOVA with post-hoc tests was used. The post - hoc tests show that the impact of the appliance is significant only at time T0. After an initial elevation, a subsequent lowering of the electromyographic values of the muscles Masseter and Temporal in patients wearing aligners (with F22 systematics) could suggest an adaptation of the entire stomatognathic system.

KEYWORDS: *clear aligners, F22, electromyography, EMG*

INTRODUCTION

Electromyography is a technique that deals with capturing, measuring and analyzing an electrical signal made by the muscles, in unfavorable conditions. The reference measurement inherent to this muscle "discharge" is expressed in microvolts (μVolts) of very low intensity (1). Electromyography arises between biology and physics, and only the technological development of recent years has allowed it to become a discipline capable of contributing fully to the knowledge of neuromuscular physiology, so as to provide a valid aid for the diagnosis of numerous pathologies of nerves and muscles (2).

Received: 16 January 2023
Accepted: 28 February 2023

The theory of Neuromuscular Occlusion recognizes the role of muscles as primum movens in the functional physiology of the stomatognathic system, influences the muscle heads and actively uses TENS (Transcutaneous Electrical Nerve Stimulation) (3), B. Jankelson in 1969 (4) began to use the patient's muscles to be pointed the physiological centric position, in 1975, with the mandibular kinesiograph he began to measure the different mandibular positions for the different functions and the different resting positions before and after TENS (5). The development of this tool, further modified the diagnostic protocol developed by Jankelson over the years (6).

Some studies (7-9) have shown that the use of these devices can reduce the parafunctional activity, which often appears in times of stress. There is also a disparity of views regarding the influence of the type of material (rigid or resilient) on the neuromuscular response of individual patients (10,11).

In the literature, studies have been reported to date concerning the muscular response of patients undergoing therapies carried out with rigid splints, or with disclusion plates, in any case devices that do not have a selectively orthodontic effect, but only of partial coverage or of the entire dental arch. As there is an increasing interest about esthetics and the use of these methods even in challenging cases (12-14), we tried to evaluate the behavior of these muscles during the first stages of orthodontic treatment with aligners (F22).

MATERIALS AND METHODS

From examining 8 patients from the Clinic of the School of Specialization in Orthodontics of the University of Ferrara, all adults, aged between 20 and 40 years, with the absence of periodontal, dental and joint temporomandibular and / or muscular pathologies in progress. Were used: K7 kinesiographic assessment system, produced by MYO-TRONICS inc. ,eight-channel electromyographic evaluation MYO-TRONICS inc., DUOTRODES dedicated bipolar electrodes, in silver / chloride for electromyography, pre-coated with gel, Aligners F22. Each session included 6 measurements (scans) of 15 seconds each, in particular, 3 scans with aligners worn and 3 scans without. A statistical analysis was then performed on a data set consisting of 8 on which four electromyographic measurements relating to individual muscle were measured over four times (0, 1, 2, 3), Left Anterior Temporal Muscle (LTA), Temporal Right Anterior (RTA), Left Masseter (LMM) and Right Masseter (RMM), with or without the presence of appliance (NO / YES). The purpose of the analysis is to verify whether and how the variations in measurements with or without a device change over time.To carry out the statistical analysis, for each measure, a repeated measures ANOVA with post-hoc tests was used.

Furthermore, the statistical software R (R Core Team 2016) and the packages lsmeans (Lenth 2016) and nlme (Pinheiro et al. 2016) were used.

The reference significance thresholds used are the following: weak (p-value between 10% and 5%), standard (p-value between 5% and 1%), strong (p-value less than 0.001).

For each measure the following are reported: the descriptive statistics (number of observations, mean, minimum and maximum standard deviation) by combination of time and device, as well as the graph. The results of the multiple measures ANOVA test which indicate, by means of the p-value, the significance of respectively: time effect, means that the measures change over time; appliance effect, if generally the presence (YES) or absence (NO) of the aligner changes the measurement; interaction effect, if the appliance effect changes over time. The post hoc analysis, means estimation of the YES / NO variation effect of the device on the measurement as time changes and related post-hoc confidence intervals.

RESULTS

Left temporal muscle (LTA)

The table shows the statistic variable for the LTA. Average value of 8 patients for the left temporal muscle

Muscle	Time of treatment	Wearing aligners	Number of patients	Average	Standard deviation	Min	Max
LTA	0	NO	8	3.6	1.7	1.5	7.1
LTA	0	YES	8	4.7	2.6	2.0	10.7
LTA	1	NO	8	3.7	1.6	1.5	7.2
LTA	1	YES	8	3.6	2.7	1.3	10.0
LTA	2	NO	8	3.7	1.7	1.4	7.3
LTA	2	YES	8	3.7	3.0	1.2	11.0
LTA	3	NO	8	3.7	1.6	1.5	7.2
LTA	3	YES	8	3.4	2.2	1.2	8.6

The post - hoc tests are reported below, showing that the impact of the appliance is only significant at time 0

Measure	Time	Difference	Estimate	p-value
LTA	0	NO - YES	-1.15	0.002515
LTA	1	NO - YES	0.0625	0.8582
LTA	2	NO - YES	-0.004167	0.9905
LTA	3	NO - YES	0.2458	0.4839

Left temporal muscle (RTA)

The table shows the statistic variable for the RTA.Average value of 8 patients for right temporal muscle

Muscle	Time of treatment	Wearing aligners	Number of patients	Average	Standard deviation	Min	Max
RTA	0	NO	8	4.4	2.6	1.6	8.8
RTA	0	YES	8	6.1	4.2	2.0	14.1
RTA	1	NO	8	4.4	2.7	1.6	9.3
RTA	1	YES	8	4.4	3.9	1.3	13.0
RTA	2	NO	8	4.5	2.7	1.6	9.4
RTA	2	YES	8	4.4	3.8	1.3	13.1
RTA	3	NO	8	4.5	2.6	1.7	9.1
RTA	3	YES	8	4.4	3.5	1.5	11.8

The post - hoc tests are reported below, showing that the impact of the appliance is only significant at time 0

Measure	Time	Difference	Estimate	p-value
RTA	0	NO - YES	-1.712	0.0008049
RTA	1	NO - YES	-25	0.9567
RTA	2	NO - YES	0.04167	0.9278
RTA	3	NO - YES	0.06667	0.8848

Left masseter muscle (LMM)

The table shows the statistic variable for the LMM. Average value of 8 patients for the left temporal muscle

Muscle	Time of treatment	Wearing aligner	Number of patient	Average	Standard deviation	min	max
LMM	0	NO	8	2.8	1.3	1.7	5.9
LMM	0	YES	8	3.6	2.0	2.2	8.3
LMM	1	NO	8	3.0	1.4	1.8	6.2
LMM	1	YES	8	2.9	2.1	1.5	7.9
LMM	2	NO	8	3.0	1.4	1.8	6.2
LMM	2	YES	8	3.1	2.4	1.5	8.8
LMM	3	NO	8	3.2	2.1	1.8	8.1
LMM	3	YES	8	3.3	2.7	1.4	9.8

The post - hoc tests are reported below, showing that the impact of the appliance is only significant at time 0

LMM, time average variation

Contrast	Estimate	SE	df	t.ratio	p-value
0 - 1	0.5312	0.245	21	2.168	0.1648
0 - 2	0.4854	0.245	21	1.981	0.2265
0 - 3	0.5979	0.245	21	2.44	0.0999
1 - 2	-0.04583	0.245	21	-0.1871	0.9976
1 - 3	0.06667	0.245	21	0.2721	0.9927
2 - 3	0.1125	0.245	21	0.4592	0.9671

Right masseter muscle (RMM)

The table shows the statistic variable for the RMM. Average value of 8 patients for right masseter muscle

Muscle	Time of treatment	Wearing aligners	Number of patients	Average	Standard deviation	Min	Max
RMM	0	NO	8	3.6	2.4	1.8	7.7
RMM	0	YES	8	4.7	3.5	2.3	10.7
RMM	1	NO	8	3.6	2.4	1.7	8.0
RMM	1	YES	8	3.4	3.1	1.5	10.4
RMM	2	NO	8	3.7	2.5	1.8	8.2
RMM	2	YES	8	3.6	3.4	1.4	11.3
RMM	3	NO	8	3.7	2.4	1.8	8.0
RMM	3	YES	8	3.6	3.3	1.4	11.1

The post - hoc tests are reported below, showing that the impact of the appliance is only significant at time 0

RMM, post hoc table

Measure	Time	Difference	Estimate	p-value
RMM	0	NO - YES	-1.117	0.007261
RMM	1	NO - YES	0.1667	0.6689
RMM	2	NO - YES	0.05417	0.8893
RMM	3	NO - YES	0.02083	0.9573

DISCUSSION

In the beginning of the orthodontic treatment with aligners (F22), there was an increase in electromyographic values: at the beginning of therapy with aligners (T0), in the condition of the appliance worn (values in microvolts rise, from "Wearing aligner" NO to "Wearing aligner" YES, in T0). In the subsequent phases of therapy (T1, T2 and T3), there was a lowering of the electromyographic values, wearing the aligners (values that drop from "Wearing device" NO to "Wearing device" YES, in T1, T2 and T3).

In the past, other authors have investigated the electromyographic behavior of the mandibular muscles, with particular reference to the Masseter and Temporal muscles. The results of these investigations essentially indicate that a skeletal expansion in the transverse plane of the maxilla generally causes an increase in the electromyographic activity of the muscles mentioned above (15,16), while we note that there are different results in studies that consider the trend of these electromyographic values measured in growing patients treated with functional devices

CONCLUSION

The present research wanted to highlight, within the proposed limits, after an initial elevation, a subsequent lowering of the electromyographic values of the muscles Masseter and Temporal in patients wearing aligners (with F22 systematics).

The very stable electromyographic picture in the months following the start of therapy, could suggest an adaptation of the entire stomatognathic system

REFERENCES

1. Bazzotti L. *L'Elettromiografia Cutanea*. Pecetto Torinese(TO),Officina Grafica la Collina, 1996.
2. Bazzotti L, Boschiero R. *Principi Di Occlusione Neuromuscolare*. Bologna, Ed. Grasso, 1991.
3. Cattaneo R, Monaco A. *Elettromiografia E Chinesiografia per La Clinica Odontoiatrica*. Ascoli Piceno, Futura Ed. 2007
4. Jankelson B, Swain CW, Crane PF, Radke JC. Kinesiometric instrumentation: a new technology. *Journal of the American Dental Association (1939)*. 1975;90(4):834-840. doi:10.14219/jada.archive.1975.0164
5. Matheson DW, Toben TP, de la Cruz DE. EMG scanning: Normative data. *Journal of Psychopathology and Behavioral Assessment*. 1988;10(1):9-20. doi:10.1007/bf00962981
6. Okeson PJ. *Il Trattamento Delle Disfunzioni Dell'occlusione E Dei Disordini Temporomandibolari*. V Edizione, Bologna, Ed. Martina, 2006.
7. Clark GT. Occlusal theraphy: occlusal appliances. In: *The President's Conference on the Examination, Diagnosis and Management of Temporomandibular Disorders*. Chicago, 1983, American Dental Association, pp. 137-146.
8. Solberg WK, Clark GT, Rugh JD. Nocturnal electromyographic evaluation of bruxism patients undergoing short term splint therapy. *Journal of Oral Rehabilitation*. 1975;2(3):215-223. doi:10.1111/j.1365-2842.1975.tb00915.x
9. SHEIKHOLESLAM A, HOLMGREN K, RIISE C. A clinical and electromyographic study of the long-term effects of an occlusal splint on the temporal and masseter muscles in patients with functional disorders and nocturnal bruxism. *Journal of Oral*

Rehabilitation. 1986;13(2):137-145. doi:10.1111/j.1365-2842.1986.tb00646.x

10. Botelho AL, Silva BC, Gentil FHU, Sforza C, da Silva MAMR. Immediate effect of the resilient splint evaluated using surface electromyography in patients with TMD. *Cranio: The Journal of Craniomandibular Practice*. 2010;28(4):266-273. doi:10.1179/crn.2010.034
11. De la Torre Canales G, Manfredini D, Grillo CM, Guarda-Nardini L, Machado Gonçalves L, Rizzatti Barbosa CM. Therapeutic effectiveness of a combined counseling plus stabilization appliance treatment for myofascial pain of the jaw muscles: A pilot study. *Cranio*. 2016;35(3):180-186. doi:10.1080/08869634.2016.1168071
12. Oliverio T, Cremonini F, Lombardo L, Siciliani G. Tooth Whitening in Association with Clear Aligner Treatment. *Journal of Clinical Orthodontics*. 2019;53(9):508-517.
13. Lombardo L, Carlucci A, Palone M, Mollica F, Siciliani G. Stiffness comparison of mushroom and straight SS and TMA lingual archwires. *Progress in Orthodontics*. 2016;17(1). doi:10.1186/s40510-016-0140-2
14. Lombardo L, Ceci M, Mollica F, Mazzanti V, Palone M, Siciliani G. Mechanical properties of multi-force vs. conventional NiTi archwires. *Journal of Orofacial Orthopedics*. 2019;80(2):57-67. doi:10.1007/s00056-018-00164-4
15. Arat FE, Arat ZM, Acar M, Beyazova M, Tompson B. Muscular and condylar response to rapid maxillary expansion. Part 1: Electromyographic study of anterior temporal and superficial masseter muscles. *American Journal of Orthodontics and Dentofacial Orthopedics*. 2008;133(6):815-822. doi:10.1016/j.ajodo.2006.07.028
16. De Rossi M, De Rossi A, Hallak JEC, Vitti M, Regalo SCH. Electromyographic evaluation in children having rapid maxillary expansion. *American Journal of Orthodontics and Dentofacial Orthopedics*. 2009;136(3):355-360. doi:10.1016/j.ajodo.2007.08.027