



Acta Scientiarum. Health Sciences

ISSN: 1679-9291

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Universidade Estadual de Maringá
Brasil

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Acta Scientiarum. Health Sciences, vol. 38, núm. 2, julio-diciembre, 2016, pp. 199-204
Universidade Estadual de Maringá
Maringá, Brasil

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Lucia Jig - temporomandibular dysfunction promotes muscle relaxation?

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ABSTRACT. Assess whether the Lucia Jig is a device that promotes masticatory muscle relaxation in individuals with temporomandibular dysfunction. This study was carried out in three stages (interviews, clinical examination, and laboratory) and participation of adult individuals, between 21 and 40 years of age, of both genders, who replied to the RDC/TMD questionnaire to diagnose muscular temporomandibular dysfunction. The Lucia Jig was prepared and electromyographic examination of the masseter and temporal muscles was performed bilaterally, in the postural condition of the mandibular at rest, after immediately installing the Lucia Jig in the oral cavity and at periods of 5, 10, 15, 20, and 30 min. The values obtained were compared using repeated measures ($p < 0.05$) over the entire duration of the experiment (0 to 30 min) with the Lucia Jig. There was an increase in the normalized electromyographic signal of the masticatory muscles, with the use of the Lucia Jig over the period of 30 min, with no statistically significant difference. Based on the results of this study through electromyographic data, the device did not promote masticatory muscle relaxation in individuals with muscular temporomandibular dysfunction.

Keywords: Lucia Jig, temporomandibular dysfunction, electromyography, masticatory muscles.

Jig de Lucia - disfunção temporomandibular promove relaxamento muscular?

RESUMO. Avaliar se o Jig de Lucia é um dispositivo que promove relaxamento dos músculos mastigatórios em indivíduos com disfunção temporomandibular. O estudo foi realizado em três etapas (entrevista, exame clínico e laboratorial) com a participação de indivíduos adultos, entre 21 e 40 anos de idade, ambos os gêneros, que responderam ao questionário RDC/TMD para diagnosticar disfunção temporomandibular muscular. O Jig de Lucia foi confeccionado e o exame eletromiográfico foi realizado nos músculos masseter e temporal, bilateralmente, na condição postural da mandíbula em repouso e imediatamente depois da instalação do Jig de Lucia na cavidade oral nos períodos de 5, 10, 15, 20 e 30 min. Os valores obtidos foram comparados ao longo de toda a duração do experimento (0 a 30 min) com o Jig de Lucia, utilizando o teste de medidas repetidas ($p < 0,05$). Houve aumento no sinal EMG normalizado dos músculos da mastigação, com o uso do Jig de Lucia ao longo do período de 30 min, sem diferença estatística significativa. Com base nos resultados deste estudo, conclui-se que o dispositivo Jig de Lucia, por meio dos dados eletromiográficos, não promove relaxamento dos músculos mastigatórios em indivíduos com disfunção temporomandibular muscular.

Palavras-chave: Jig de Lucia, disfunção temporomandibular, eletromiografia, músculos mastigatórios.

Introduction

The Lucia Jig is a very important clinical device used in dental science, as a differential diagnosis method to detect occlusal interferences in the centric relation position, fundamental in planning prosthetic oral rehabilitation (Lucia, 1964; Venturelli, Zuim, & Garcia, 2009; Nassar et al., 2012).

For oral prosthetic rehabilitation and myorelaxant occlusal splints to have functional harmony with the stomatognathic system, all

laboratory stages and clinical procedures of preparing the prosthetic devices are required to be properly carried out, respecting the technical scientific principles (Ewoldsen, 2011; Karakis, Dogan, & Bek, 2014; Dalewski, Chruściel-Nogalska, & Frączak, 2015). The frontal technique of mandibular manipulation of the centric relation position is facilitated by masticatory neuromuscular reprogramming, effective in occlusal adjustment therapy, in detection of occlusal interferences, and in the stability of the restorative prosthetic treatment (McKee, 2005).

With the purpose of obtaining morphological and functional records in the stomatognathic system, we sought to research and understand the effects on the masticatory muscles, of the clinical procedures performed in the oral cavity for the preparation of prosthetic devices in healthy individuals with temporomandibular dysfunction (Jaeger, 2013).

Epidemiological studies have shown that 20% of the world's population has at least one sign or symptom of temporomandibular dysfunction (Pedroni, Oliveira, & Guaratini, 2003; Herpich et al., 2014), which includes mouth opening limitation, orofacial pain, and requires specific treatment to perform the established function to balance the stomatognathic system, thus improving the quality of life (Suvinen, Reade, & Dworkin, 2005; Al-Khotani et al., 2016). In Brazil, 36.2% of the adult population has some temporomandibular dysfunction sign, however only 5.1% have functional limitation (Progiante et al., 2015).

Therefore, we understand the importance of establishing a study to evaluate the stomatognathic system, through electromyographic activity of the masticatory muscles and the Lucia Jig usage time in the oral cavity, which will help dental surgeons understand the dynamics of the mastication muscles and the correct time of device use, as a possible neuromuscular reprogramming tool.

Material and methods

The research was approved by the Research Ethics Committee of the Ribeirão Preto Dental School, University of São Paulo, according to Resolution 466/2012 of the National Council of Brazilian Health under number 08357712.3.0000.5419. All participants were informed about the experiment and agreed to participate by freely and clearly signing the informed consent form.

Sample

The convenience sample was initially selected from a population consisting of 150 volunteers aged between 21 to 40 years (mean age of 28.0 ± 3 yrs) and evaluated from the Occlusion and Orofacial Pain Service Demystifying Service of Patients with Special Needs of Ribeirão Preto Dental School, University of São Paulo, Brazil.

In the first phase of the study, an interview was carried out with the purpose of obtaining information relating to personal data, medical and dental history, presence of systemic disease requiring chronic or local medication, use of

medications that could interfere with muscle activity, and the presence of signs and symptoms of temporomandibular dysfunction. In the s phase, we performed the clinical examination to observe the presence of the maxillary anterior teeth, mandibular anterior, and first permanent molars (upper and lower), and presence of muscular temporomandibular dysfunction, previous or current orthodontic treatment, speech therapy or otorhinolaryngology; and evaluation of periodontal disease, inspection of dental restorations with risks of fractures.

A questionnaire of diagnostic criteria for temporomandibular dysfunction was used (RDC/TMD) with the purpose of diagnosing the types of temporomandibular dysfunction, because the greatest methodological error is the definition of the population to be analyzed. The RDC/TMD offered a classification system according to their physical conditions (Axis I). Based on Axis I, the individuals were divided into three situations, including muscular temporomandibular dysfunction, displacement of the articular disc, and general conditions of temporomandibular articulation (Schiffman et al., 2014).

In the interview, 21 individuals had a clinical history of systemic diseases and were excluded from the study. In the clinical examination, 25 individuals were under orthodontic treatment, speech therapy or otorhinolaryngology treatment; 35 individuals had absence of maxillary and mandibular anterior teeth or the first permanent molars (upper and lower), 18 individuals experienced displacement of articular discs, 18 individuals presented no temporomandibular dysfunction, being considered healthy subjects, and 33 individuals had a confirmed diagnosis of muscular temporomandibular dysfunction and were included in this study.

Laboratory phase

A Lucia Jig device was prepared in chemically activated acrylic resin (Duralay - Reliance Dental Mfg. Co., Worth, IL, USA), directly in the oral cavity and adapted onto the maxillary central incisor teeth, obtaining disclusion of up to 1 mm between the upper and lower teeth (Figure 1) (Nassar et al., 2012).

After preparing the device, the collection of electromyographic data was performed through the Myosystem BR-1 electromyography (DataHomins Ltd), with simultaneous acquisition, common grounding to all channels, low-pass filters of 10 Hz to 5 KHz; channel input impedance of 10 g in differential mode, 12 bits of dynamic resolution

range, amplitude range of -10 to +10 v, and a channel sampling frequency of 2 KHz (Figure 2).

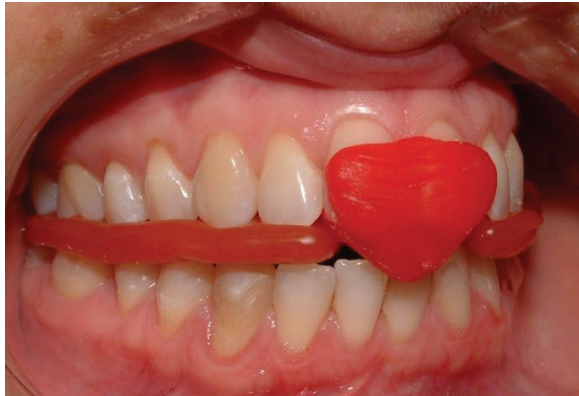


Figure 1. Lucia Jig positioned in the dental arch.

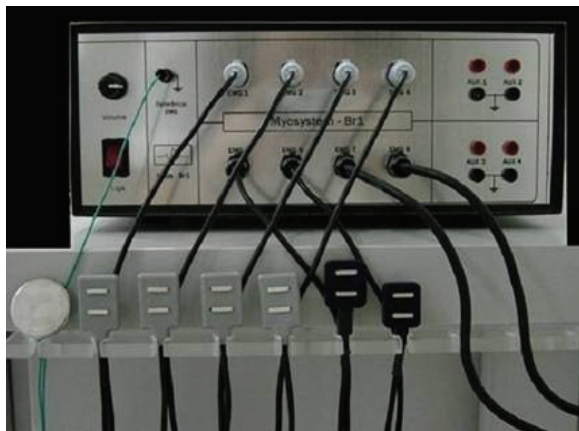


Figure 2. Myosystem BR-1.

The surface electrodes were attached with adhesive tape onto the masseter and temporal muscles. The location of these muscles was evaluated by the specific maneuvers of maximum voluntary contraction (De Luca, 1997). As reference electrode, we used a circular stainless steel electrode with 3 cm in diameter, placed on the skin of the inner right wrist region. The participant was instructed to remain as relaxed as possible before the electromyographic evaluations. In the first electromyography performed, the condition of teeth clenching in maximum voluntary contraction was administered for 4 s. Before starting the s electromyography, the participant remained at rest for 4 min. Then, we performed the registration of myoelectric activity in the postural condition with the mandibular at rest for 4 s. The following condition was immediately recorded at the placement of the Lucia Jig and at periods of 5, 10, 15, 20, and 30 min of contact with the lower incisors. Each electromyographic recording was performed for 4 s.

Statistical analysis

The electromyographic data were tabulated and normalized by the maximum voluntary contraction. The descriptive analysis (mean and standard error) was performed for each variable. The mean electromyographic values were obtained using the repeated-measures test (significance level of 5 and 95% CI). The data were analyzed using the SPSS version 21.0 for Windows (SPSS Inc., Chicago, IL, USA).

Results and discussion

Table 1 shows the normalized electromyographic data of the masseter and temporal muscles with the mandibular at rest and using the Lucia Jig at periods of 0 to 30 min, in patients with muscular temporomandibular dysfunction. There was no statistically significant difference ($p < 0.05$) when comparing the condition of the mandibular at rest and the times stipulated in this study, in the analysis of the masseter and temporalis muscles.

Table 1. Means, standard error, and statistical significance ($p < 0.05$) for the normalized electromyographic data of the right masseter muscle (RM), left masseter (LM), right temporal (RT), and left temporal (LT) in individuals with muscular TMD, in the condition of the mandibular rest (I), after immediate installation of the Lucia Jig (II) and at times of 5 (III), 10 (IV), 15 (V), 20 (VI) and 30 (VII) min.

Time	Masticatory Muscles			
	RM	LM	RT	LT
I	0.06 ± (0.01)	0.09 ± (0.02)	0.16 ± (0.02)	0.12 ± (0.01)
II	0.09 ± (0.02)	0.11 ± (0.02)	0.16 ± (0.02)	0.12 ± (0.02)
III	0.08 ± (0.01)	0.10 ± (0.02)	0.16 ± (0.02)	0.12 ± (0.01)
IV	0.08 ± (0.01)	0.11 ± (0.02)	0.17 ± (0.02)	0.12 ± (0.01)
V	0.08 ± (0.01)	0.10 ± (0.02)	0.18 ± (0.02)	0.13 ± (0.01)
VI	0.09 ± (0.01)	0.10 ± (0.02)	0.19 ± (0.02)	0.13 ± (0.01)
VII	0.09 ± (0.01)	0.12 ± (0.03)	0.19 ± (0.02)	0.14 ± (0.02)
p	0.12	0.31	0.08	0.56

Method of error

The method error (Se) was calculated using Dahlberg's Equation 1:

$$Se = \sqrt{\sum d^2/2n} \quad (1)$$

where:

'd' was the difference between the two participant's measurements, and 'n' was the number of double measurements. The percentage error was calculated using the formula $\% = (Se/\text{mean}) \times 100$, where 'Se' was the result of Dahlberg's formula, and the mean corresponded to the total mean value of the first and s measurements. The method of error of the electromyographic measurement was calculated using the records of ten individuals, during two different sessions, with a seven-day interval. There was a small percentage difference between the first and s session of 4.83 for the electromyography.

Among the challenges faced by dental professionals in the daily clinical practice orofacial pain has been highlighted and careful diagnosis is necessary, with temporomandibular dysfunction being a syndrome associated with cases of painful symptoms (Silva, Silva, & Oliveira, 2011; Stuhr, Earnshaw, & Duncombe, 2014).

Many situations such as deliberate unilateral chewing, limited and sporadic locking of mouth opening, articulation noises, and muscle pain can begin in an inadequate occlusion, unbalanced, a parafunctional overload, or an interfering dental element (Pereira, Steenks, & Van Der Bilt, 2009; Lima, Cavalcanti, & Marchi, 2010).

To detect such interferences, occlusal devices that promote muscle reprogramming are useful, because they allow you to check dental contact without adapted mandibular deviations to achieve the maximum habitual intercuspation (Zuccolotto et al., 2007). With these devices, the dental surgeon can detect the interfering occlusal factors and eliminate them which is an extremely important starting point for prosthetic rehabilitation treatments for healthy subjects and for those with temporomandibular dysfunction (Wang & Mehta, 2013).

A specific study of the maxillomandibular relationship in centric relation confirms the occlusal relationship between antagonist teeth. It is a reliable and reproducible reference and controls the pattern of occlusal contact, helping to detect interferences and prematurity (Bodere & Woda, 2008; Padala, Padmanabhan, & Chithranjan, 2012).

The Lucia Jig device was used in this study with the purpose of assessing whether dememorization of tissue actually occurs, releasing tension, due to the loss of proprioceptive memory of interfering teeth, causing muscle relaxation. The individual has to be with relaxed and asymptomatic muscles to reach the proper position of centric relation (Dupas, Picart, & Graux, 1990).

The concept of reprogramming is based on the level of muscle contraction that is necessary to perform the mandibular movements in a coordinated and comfortable manner, which is characterized by a shorter period of muscle relaxation, as a form of functional adaptation of the stomatognathic system (Land & Peregrina, 2003).

Surface electromyography was the method used in this study to analyze the possible changes in the electromyographic activity of the masseter and temporalis muscles (Regalo et al., 2008; Oliveira et al., 2014) regarding Lucia Jig usage time as neuromuscular reprogramming in individuals with temporomandibular dysfunction.

In this study, it was observed that the 5 and 15 min time using the Lucia Jig produced changes in the electromyographic activity of the masticatory muscles. In the period of 5 min, an increase occurred in the electromyographic activity of the right and left masseter muscle; and in the period of 15 min, there was hyperactivity of the electromyographic pattern of temporal muscles, compared to the condition of the mandibular at rest, with no statistically significant difference. The morphological and functional characteristics of the masticatory muscles, which are to sustain and position the mandible, collaborate with the adjustment and synchronization of the direction of mandibular dynamic movement (Kanayama, Minowa, & Kawasaki, 2000). This fact would explain the myoelectric changes of the masticatory system, because the proprioceptive action and the muscle response, due to the force exerted, even if minimal, of the contact of the lower teeth with the Lucia Jig, to keep the mandible in position, would alter the masticatory muscular dynamics, leading to an increase in the tonus, tension of the muscle fibers, and hyperactivity (Uhač, Kovac, & Grzić, 2003; Bersani et al., 2011). Daily behavioral stress and orofacial pain, variables not evaluated in this study, may also interfere with muscle dynamics, providing hyperactivity of the masticatory muscles (Cecilio et al., 2010).

Donegan, Carr, and Ziebert (1990) reported that neuromuscular reprogramming devices, used for 15 min, do not alter the electromyographic patterns of the masticatory muscles, but Nassar et al. (2012) confirmed that using this device in healthy individuals promotes change in masticatory myoelectric activity over a time period of 30 min. Data were confirmed by this study, in the evaluation of individuals with muscular temporomandibular dysfunction, who used the Lucia Jig device.

This study sought the proper proportion of the Lucia Jig in the oral cavity, while respecting the functional freeway space of 3 mm; therefore, the changes in muscle activity were not related to inadequate preparation of this device, which could invade the functional freeway space, causing functional imbalance and muscle hyperactivity (Jahangiri & Jang, 2002).

Often times, when evaluating individuals' occlusion after prosthetic or orthodontic restorative treatments, it is observed that certain dental elements concentrate on greater occlusal load than others, when there might be a more effective and appropriate distribution of this force, to avoid problems occurring from this situation (Parnia, Moslehifard, & Pournasrollah, 2014). This is

explained by the incorrect position of the mandible in the centric relation, caused by ineffective or non-existent muscle relaxation, leading to inadequate technical maneuvers of the mandibular. For this reason, it is important to make an accurate assessment of oral prosthetic rehabilitation treatments that were unsuccessful and to observe the inherent cause.

Therefore, this study investigated the effect of the Lucia Jig in the masticatory muscles of individuals with muscular temporomandibular dysfunction, over the time period of 30 min, with the purpose of evaluating if reprogramming of proprioceptive memory occurs, in order to establish and facilitate obtaining the centric relation, to allow the centralized position of the condyles along with their respective articular discs inside of the articular fossa, to assist in the occlusal adjustment, and to direct the thickness of the myorelaxant occlusal splint.

Conclusion

A Lucia Jig device, regarding the electromyographic signal, provided changes in the activity of the masseter and temporalis muscles, in relation to the postural position of the mandibular at rest of individuals with muscular temporomandibular dysfunction, raising the electromyographic signal.

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Received on May 3, 2016.

Accepted on June 16, 2016.

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