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Original

Electromyography of masticatory muscles after denture relining with soft and hard denture liners

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Abstract: **We evaluated electromyograms of masticatory muscles after denture relining with soft and hard liners. In total, 44 patients with complete dentures were studied: 22 underwent chairside relining of mandibular dentures with a soft, silicone-based liner (Mucopren Soft); the other 22 underwent relining with a hard, acrylic resin-based liner (Kooliner). Electromyograms of the masseter and temporal muscles were obtained before (T0) and 90 days after (T90) relining. Participants performed a maximum voluntary contraction (static test), on which percentage-overlapping coefficient (%), mandibular displacement (%), and standardized electromyographic activity, i.e., impact, (µV/µVs %) were analyzed. Participants were also asked to chew a wafer, cereal bar, and peanuts (dynamic test) to determine symmetrical mastication index (SMI%), frequency (Hz), and impact. The data were analyzed using a generalized linear model (α = 0.05). On the static test, mandibular displacement was lower and impact was higher at T90, as compared with baseline. On the dynamic test, SMI and impact were higher after relining for all foods. Frequency at T90 was higher only during cereal and peanut mastication. There were no differences between groups except for greatest impact during wafer chewing in patients with hard liners. Relining with hard and soft materials increased electromyographic activity and improved masticatory function. There was little difference between groups.**
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Keywords: complete dentures; denture liners; electromyography.

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Introduction

Edentulism is a serious health concern worldwide (1). Longer life expectancy has increased human exposure to oral diseases; therefore, the number of edentulous individuals will likely remain high during the next decades. Due to the potential quality of life concerns, prosthetic treatments are necessary to manage edentulism, which is strongly associated with aging and low income. Despite the success of implant-retained prostheses in treating edentulism, their use is often precluded due to systemic, financial, or psychological constraints (2). For this reason, conventional complete dentures are still widely used to treat edentulism.

Conventional dentures improve mastication, speech, and aesthetics; however, many patients are unsatisfied with them, and particularly with mandibular dentures, because of discomfort, instability, and lack of retention (3). Denture liners can be used to address these complaints. A cross-over trial found that patients preferred to have their dentures relined with soft materials rather than with hard resin (4). Other studies showed that such materials enhanced functional activities (2,5) by improving denture stability and comfort, and by absorbing impacts and the distribution of masticatory load on the denture-bearing area (6-9).

Table 1 Characteristics of groups and denture liner materials used in the study

Group/denture liner	Composition	Manufacturer	Batch number	Service life
Group 1: Mucopren Soft	Silicone-based polyvinyl siloxane; 2-paste system	Kettenbach GmbH & Co. KG, Eschenburg, Germany	20893	3 years
Group 2: Kooliner	Acrylic resin-based polymethyl-methacrylate; Powder/liquid system	GC America Inc., Alsip, IL, USA	50122	1.5 years

Denture liners are classified as hard or soft, acrylic resin-based or silicone-based, and chemically or thermally polymerized and are indicated for temporary and permanent use (10). Due to this variety of classifications, dentists have difficulty choosing the ideal material for particular clinical cases. When a treatment such as denture relining is proposed, in addition to concerns regarding patient satisfaction, the impact of the intervention on stomatognathic function should be assessed (11,12). Functional evaluations may include surface electromyography (EMG) of masticatory muscles (13,14), which can be an excellent method of measuring muscular activity, stability, and comfort during static (maximum voluntary clenching) and dynamic (mastication) tasks (15).

Our literature review identified few studies of denture liners and surface electromyography, and the results were conflicting (2,16-18). Additionally, no previous study compared hard and soft denture liners in relation to their influence on muscle function. Therefore, we used surface electromyograms obtained during static and dynamic tasks to evaluate masticatory muscle function after denture relining with hard (acrylic resin-based) and soft (silicone-based) denture liners. The null hypotheses were that there would be no electromyographic differences between these groups and that relining would not improve muscle function.

Material and Methods

This study enrolled patients with complete dentures, who were then grouped according to the type of chairside reliner used. The study outcomes were electromyographic parameters at 90 days.

The present study was developed by five trained dental researchers: researcher number 1 (VMFL) was responsible for collecting patient sociodemographic data; R2 (MXP) obtained data from the electromyography exams; R3 (CHLS) was a dentist specializing in prosthodontics and performed the clinical intervention, i.e., denture relining; and R4 (RFS) and R5 (MAMRS) did the statistical analysis. All researchers except R3 (CHLS) were blinded to the group allocation. Blinding to the intervention was deemed infeasible because the materials being used were obvious to both the patients and clinicians (R3) (5).

Study participants

The participants were edentulous patients that had requested new conventional complete dentures from Ribeirao Preto Dental School, due to dissatisfaction with their existing dentures. The main reasons for dissatisfaction included pain, poor retention, and impaired function. The researchers fabricated new dentures, which were delivered to patients after the end of the present study. The experimental protocol was conducted in accordance with the Declaration of Helsinki and was administered only after participants indicated that they understood the study goals and design and gave their written informed consent. The study was reviewed and approved by the relevant institutional ethics committee (protocol number CAAE 0054.0.138.000-09).

Dentures and the oral cavity were clinically examined and radiographs and a clinical history of the patient were obtained to determine if patients satisfied the study inclusion criteria, namely, age between 40 and 80 years, edentulism, and use of complete dentures. In addition, existing maxillary and mandibular complete dentures had to have been fabricated with heat-polymerized acrylic resin and had to have been worn for at least 1 year because, according to Tallgren and Tryde (19) electromyography signals stabilize after 6 months of denture use. Also, the selected dentures had to have occlusal relations with no major alteration of occlusion or centric relation on the vertical dimension. Only participants with healthy mucosa (i.e., no signs of inflammation, traumatic lesions, candidiasis, or hyperplasia) were enrolled. Finally, moderate mandibular alveolar ridge resorption and a resilient mucosa were necessary to be considered for relining with either denture liner.

We excluded participants whose dentures had a deteriorated intaglio surface, large areas of fracture, a severely altered occlusal vertical dimension, extremely worn artificial teeth, or very unsatisfactory occlusion. Participants with neurological diseases, lack of motor coordination, or cognitive difficulties were also excluded, as were patients with residual roots, cysts, or bone spicules, temporomandibular dysfunction, or allergies to methacrylate or silicone. Knife-edge mandibular ridges were deemed unsuitable for relining.

A single assessor (R1) collected data on patient sex, age, education, marital status, profession, income, duration of edentulism, and age of existing dentures.

Interventions

Table 1 shows the groups and denture liners used in the present study. Only mandibular dentures were relined. The procedures were done using the chairside procedures recommended by the manufacturers.

Dentures were removed from the oral cavity, sonicated for 15 min, and then cleaned by brushing. The impression surface of the mandibular dentures was worn by 2 mm with drills (MaxiCut, Malleifer SA, Ballaigues, Switzerland), taking care to preserve the borders. After insertion of the approximately 2-mm–thick denture liners, the dentures were adapted to the mouth, and the patient was asked to occlude the maxillary and mandibular dentures and move his/her tongue. Then, researcher R3 guided movements of the muscles, cheeks, and lips (20). After setting, the mandibular dentures were removed from the oral cavity for finishing with a pair of scissors (for the soft liner) or drills (for the hard liner). The retention, support, stability, and occlusal interferences of the dentures were analyzed and adjusted. Participants returned for adjustments after 24, 48, and 72 h.

EMG recordings and measurements

Instrumentation

The masseter and anterior temporal muscles on both sides (left and right) were examined. Before electrode placement, the skin was cleaned with ethanol to reduce impedance (11). Disposable pre-gelled silver/silver chloride bipolar surface electrodes (diameter 10 mm, inter-electrode distance 21 ± 1 mm; Hall Ind. & Com. LTDa, Sao Paulo, SP, Brazil) were positioned on the muscle bellies, parallel to the muscle fibers (13,15). A disposable reference electrode was applied to the forehead to eliminate external interference. EMG activity was recorded using a computerized instrument (Freely, De Götzen srl; Legnano, Milano, Italy). The software package EMA (De Götzen srl) was installed on a computer and averaged signals over 25 ms; muscle activity was assessed as the root mean square (RMS) of the amplitude (V). EMG signals were recorded for further analysis (11).

Two electromyographic exams were performed: a static (clenching) and a dynamic test (mastication). During both tests, the subjects sat with their heads unsupported and were asked to maintain a natural, erect position. To avoid effects due to fatigue, a rest period of at least 3 min was allowed between the standardization recording and tests, as well as between tests (11). Both electromyographic exams were performed twice: at T0 (baseline), with conventional dentures and before relining, and at T90, i.e., 90 days after relining.

Static test

Standardization recording

To standardize the EMG potentials of the four analyzed muscles with tooth contact, two 10-mm–thick cotton rolls (Roeko Luna number 2, Coltene, Roeko, Germany) were positioned on the mandibular first and second molars of each subject, and a 5-s MVC (maximum voluntary clenching) recording was obtained (15,21).

MVC: data collection and analysis

After the standardization, EMG activity was recorded during MVC in intercuspidation. The subject was asked to clench as hard as possible and to maintain that level of contraction for 5 s. The exam was repeated three times, and visual feedback using the amplitudes (RMS) of EMG signals was provided to all subjects to ensure maximal performance. During these tests, the subjects were verbally encouraged to perform at their best and to maintain contraction force until the end of the test period (11,21).

For all tests, the best 3-s period (that with the most constant RMS EMG signal) was automatically selected by the software and used in all subsequent analyses. All calculations were automatically performed by the EMA software. For each patient, the EMG potentials recorded for the analyzed muscles during MVC testing were expressed as a percentage of the mean potential, as recorded during the standardization test (MVC on the cotton rolls), namely, $\mu V / \mu V \times 100$ (21). All subsequent calculations were made with the standardized potentials.

Variables analyzed in the static test

To assess the muscle symmetry of each subject, the EMG waves from paired muscles were compared by computing a percentage-overlapping coefficient (POC unit %) (15). POC is an index of the symmetric distribution of muscular activity, as determined by occlusion. The index ranges from 0% to 100%: when two paired muscles contract with perfect symmetry, the POC is 100%. Masseter and temporalis POCs were obtained for each subject. The two EMG waves were then superimposed, and the ratio between superimposed areas and the total areas was computed as:

$$\text{Poc} = \left[1 - \sum_{i=1}^{60}(\text{right muscle}_i - \sum_{i=1}^{60}\text{left muscle}_i) \,/\, (\text{right muscle}_i + \text{left muscle}_i)\right] \times 100$$

where *i* represents RMS potentials averaged over each 50-ms period.

A very strong muscle coupled with a very weak muscle will have a percentage contribution equal to or slightly less than 100%, whereas a couple of muscles with oscillating contractions will each have percentage contributions of around 50% (22).

EMG waves of the left and right masseter and temporalis anterior muscles of each subject were further analyzed to identify possible laterodeviation of the mandible during the test, as indicated by unbalanced TR (temporal right) and ML (masseter left) or TL (temporal left) and MR (masseter right) couples. Ferrario et al. (22) described how the direction of the forces of the masseter and temporal muscles could result in laterodeviation of the mandible, e.g., when the force of the temporal muscle on one side is directed upward and backward while the force of the contralateral masseter is directed upward and forward.

A force couple that causes temporal deviation of the mandible could thus be produced and was identified by calculating torque coefficient (*TC*, unit %):

$$\text{Tors} = \overset{60}{\underset{i=1}{\mathrm{I}}}\delta \mathrm{T}i - \overset{60}{\underset{i=1}{\delta}}\mathrm{M}i\mathrm{I}\ (\mathrm{MR}i + \mathrm{ML}i + \mathrm{TR}i + \mathrm{TL}i) \times 100$$

where *i* represents RMS potentials averaged over each 50-ms period and $\delta \mathrm{M}i = \mathrm{MR}i - \mathrm{ML}i$, and $\delta \mathrm{T}i = \mathrm{Tr}i - \mathrm{TL}i$ are the non-overlapped left and right muscular areas of the masseter (M) and temporal (T) muscles.

TC ranges from 0% (no torque during test) to 100% (significant laterodeviation of mandible). *TC* is obviously null when the test is performed with perfectly symmetric muscular contractions ($\Delta t = 0$, $\delta M = 0$, and $POC = 100\%$). If the difference ($\delta T - \delta M$) is negative (<0), the couple will cause left-side laterodeviation. If it is positive (>0), the result is right-side laterodeviation. We calculated the percentage contribution of left- (negative differences) and right-side (positive differences) laterodeviation.

Mean (masseter and temporalis) total standardized muscle activity (µV / µVs %), or impact, was calculated as the integrated areas of the EMG potentials over time (13).

Table 2 Qualitative sociodemographic characteristics of participants

Variable	Group 1, no.	Group 2, no.	*P* value
Sex			
Female	18	17	0.71[a]
Male	4	5	
Marital status			
Married	12	14	
Single	0	0	0.54[a]
Divorced	1	0	
Widower	9	8	
Education			
Illiterate	9	6	
Some primary education	6	7	
Primary education	4	7	0.47[b]
Some secondary education	2	1	
High school graduate	1	1	
University graduate	0	0	
Profession			
Retired	15	16	
Unemployed	0	0	0.74[a]
Employed/self-employed	7	6	

[a]χ^2 test; [b]Mann-Whitney test; *Significant ($P \leq 0.05$)

Dynamic test

Electromyographic activity of the masseter and temporalis muscles was recorded during unilateral (left and right) chewing of the following foods: 1) a wafer (soft food; Bis, Lacta S/A, Curitiba, PR, Brazil): half the wafer was chewed on the right side and the other half was chewed on the left side; 2) a cereal bar (food of moderate hardness; Nutry, Nutrimental S/A, Sao Jose dos Pinhais, PR, Brazil): one-quarter of the cereal bar was chewed on the right side and another one-quarter of the bar was chewed on the left side; and 3) peanuts (hard food; Mendorato, Santa Helena, Ribeirao Preto, SP, Brazil): three units of peanuts was chewed on the right side and another three units was chewed on the left side.

For each patient, EMG potentials produced during the first 15 s of each unilateral chewing episode were recorded and standardized, as detailed above (µV / µV × 100). Masticatory frequency was calculated from recordings of EMG potentials of evaluated muscles during each chewing test. To determine if the left- and right-side chewing tests were performed with symmetrical muscle patterns, the symmetrical mastication index (SMI, %), or neuromuscular coordination, was computed (13). SMI ranges from 0% (asymmetrical muscle pattern) to 100% (symmetrical muscle pattern).

Mean (masseter and temporalis) total muscle activity during chewing was computed as the integrated areas of the EMG potentials over time (13). For each patient, "standardized" activity (impact), as determined from standardized EMG potentials (µV / µVs %), was calculated.

Estimation of sample size

Data from a previous study (20) were used to calculate appropriate sample size. A sample of 20 patients per

Table 3 Quantitative sociodemographic characteristics of participants

Variable	Mean (SD) Group 1	Mean (SD) Group 2	Statistical analysis (*P* value)
Age (years)	65.0 (9.0)	64.7 (9.0)	*t*-test (*P* = 0.92)
Duration of edentulism (years)	14.5 (7.6)	16.5 (8.2)	*t*-test (*P* = 0.40)
Monthy income (R$)	1,081.8 (598.1)	944.5 (458.5)	*t*-test (*P* = 0.40)
Age of dentures (years)	10.5 (5.6)	11.7 (6.7)	*t*-test (*P* = 0.55)

*Significant ($P \leq 0.05$); R$ 1.84 (Brazilian currency) = 1 US$ (in May 2012)

Table 4 Comparison of results within and between groups on static testing

Variable	Unit	G1	G2	*P* (group)	T0	T90	*P* (time)
POC Masseter	%	80.2 ± 6.9	78.8 ± 8.8	0.55	78.9 ± 8.2	80.1 ± 7.7	0.14
POC Temporal	%	83.5 ± 4.5	81.1 ± 6.7	0.10	82.6 ± 6.3	82 ± 5.7	0.46
Tors	%	11.3 ± 2.9	11.3 ± 2.3	0.97	12.1 ± 2.8	10.5 ± 2.0	< 0.001*
Activity standardized	μV/ μVs%	92.6 ± 17.8	84.1 ± 14.4	0.06	83 ± 14.3	93.7 ± 17	< 0.001*

G1, Group 1; G2, Group 2; POC, percentage-overlapping coefficient; Tors, mandibular displacement; Values are mean ± SD; *Significant ($P < 0.001$)

group (soft and hard denture liners) would provide 80% power, assuming a type I error rate of 0.05. However, to avoid insufficient statistical power due to withdrawals, 50 patients were recruited.

Statistical analysis
The sociodemographic data from the soft and hard groups were analyzed with the χ^2 test, *t*-test, and Mann-Whitney test (Tables 2 and 3) ($\alpha = 0.05$). A generalized linear model was used to compare electromyographic data within groups (time comparison) and between groups ($\alpha = 0.05$). All statistical tests were performed using PASW Statistics, version 18 (SPSS Inc., Chicago, IL, USA).

Results
Fifty patients agreed to participate and were allocated to two groups: those receiving soft ($n = 25$) and hard ($n = 25$) denture liners. One patient from the soft group withdrew due to an illness that occurred before the relining procedure. The remaining 49 patients had their mandibular dentures relined, and electromyograms were collected at T0. At T90, two patients who had received soft liners withdrew because of general health problems and three patients who had received hard liners withdrew for personal reasons. The final sample thus comprised 44 patients, 22 in each group.

Sociodemographic characteristics
As shown in Tables 2 and 3, there was no significant difference in sociodemographic characteristics between groups. The groups were similar with regard to sex, age, education, marital status, profession, monthly income, duration of edentulism, and age of existing dentures.

Static test
As shown in Table 4, the POCs for the masseter and temporalis muscles were unchanged at T90. However, Tors values were significantly lower at T90, and electromyographic standardized activity (impact) was higher at T90. There was no significant difference between groups for any variable.

Dynamic test
At T90, SMI and electromyographic standardized activity (impact) were higher during mastication of all test foods, but masticatory frequency was higher only during mastication of the cereal bar and peanuts. There was no significant difference between groups for any variable except electromyographic standardized activity, which was significantly higher during wafer mastication among patients with hard liners.

Discussion
We analyzed electromyograms of masticatory muscles after mandibular denture relining with soft and hard denture liners. Mandibular dentures were chosen for relining because they are more often the cause of the discomfort and instability that lead to dissatisfaction and often abandonment of dentures (3).

There was no difference between groups for most electromyographic variables. This result was unexpected, as previous studies found that the greater resilience of soft liners resulted in better masticatory load distribution and absorption of impacts, and thus greater comfort (7-9). If only the soft denture liner had been investigated in this study, we would not know if improvement in muscular activity were attributable to the softness of the material

Table 5 Comparison of results between groups on dynamic testing

Variable	Unit	Test food Wafer			Cereal			Peanuts		
		G 1	G2	*P*	G 1	G 2	*P*	G 1	G 2	*P*
SMI	%	50.7 ± 10.4	56.8 ± 13.9	0.08	53.6 ± 10.1	58.3 ± 13.6	0.18	54.4 ± 11.8	57.4 ± 16.9	0.47
Frequency	Hz	1.45 ± 0.16	1.47 ± 0.13	0.53	1.46 ± 0.12	1.5 ± 0.12	0.17	1.56 ± 0.13	1.54 ± 0.17	0.56
Activity standardized	µV/ µVs%	69.3 ± 18.8	80.8 ± 12.7	0.01*	84.5 ± 20.4	87.3 ± 14.9	0.59	98.1 ± 23.4	93.8 ± 16.5	0.42

G1, Group 1; G2, Group 2; SMI, symmetrical mastication index; T0, baseline; T90, day 90; Values are mean ± SD; *Significant ($P < 0.001$)

Table 6 Comparison of results within groups on dynamic testing

Variable	Unit	Test food Wafer			Cereal			Peanuts		
		T0	T90	*P*	T0	T90	*P*	T0	T90	*P*
SMI	%	51.8 ± 12.2	56.2 ± 11.4	0.001*	52.9 ± 11.9	59 ± 11.8	0.001*	52.9 ± 14.1	58.9 ± 14.6	0.001*
Frequency	Hz	1.45 ± 0.15	1.46 ± 0.14	0.68	1.45 ± 0.13	1.51 ± 0.11	0.001*	1.52 ± 0.14	1.58 ± 0.15	0.03*
Activity standardized	µV/ µVs%	72 ± 5.7	78 ± 17.8	0.001*	81.2 ± 15.9	90.6 ± 18.5	0.001*	88.8 ± 15.9	103 ± 21.8	0.001*

SMI, symmetrical mastication index; T0, baseline; T90, day 90; Values are mean ± SD; *Significant ($P < 0.001$)

or to the effects of relining itself. Therefore, inclusion of a hard denture liner group was necessary to eliminate this possible bias. It is important to emphasize that the clinical indications for these liners differ; they have different characteristics and both cannot always be used for the same cases of edentulism. However, in the present study only mandibular ridges with moderate resorption and resilient mucosa were considered candidates for relining, and these are common indications for soft and hard denture liners.

Electromyography was used to analyze masticatory muscles during static and dynamic tasks. During clenching we expected that increased retention and fitting of mandibular dentures, the distribution of masticatory loads, and the comfort possibly provided by relining (5,8) would increase POC. However, no change in POC was seen in temporal or masseter muscles between T0 and T90 for either liner. According to Tartaglia et al. (11), the symmetrical distribution of muscle activity during maximum intercuspidation is largely determined by occlusion. In the present study, patients who had prostheses with interferences or unsatisfactory occlusion that impaired chewing were excluded. We assume that relining had no effect on occlusion, which thus remained unchanged at T90, thereby explaining the unaltered POC.

However, mandibular displacement (Tors) had decreased at T90. Relining may have resulted in greater simultaneous and coordinated contraction of the contralateral muscles responsible for Tors, probably due to increased denture stability. The uniform distribution of masticatory stress on the alveolar ridge may have facilitated maximum intercuspidation without overloading a particular muscle more than any other (5,11).

Total electromyographic standardized activity (impact) was higher at T90. In two studies by Caloos et al. (23,24), low muscle effort in denture wearers—due mainly to advanced age and denture discomfort—led to muscle disuse atrophy and weakening of jaw muscles. Muscle effort, potential, and strength are significantly greater if dentures have good retention and stability (24). Relining may have increased stability and retention of mandibular dentures, which gradually augmented strength and muscular effort and consequently increased electromyographic activity, as greater energy was expended by muscles to perform the requested action. In addition, Abarca et al. (25) reported that edentulous patients have receptors on the gingiva, alveolar mucosa, and bone; however, receptors on the periodontal ligament were lost due to extraction of teeth. The authors maintain that increased muscle activity in edentulous patients is due to the absence of feedback inhibition, which is achieved by receptors on the periodontal ligament in dentate individuals.

In dynamic testing of mastication of food of various consistencies, SMI was significantly higher at T90, as was masticatory frequency during mastication of cereal and peanuts. Takahashi (16) found that, after relining, muscles functioned more rhythmically, movements were easier, and occlusal forces increased during mastication of peanuts. In addition, number of strokes and mastication time decreased. According to Veyrune et al. (26), Berrentin-Felix et al. (27), and Tartaglia et al. (11), chewing is determined by the central nervous system and is adapted to food hardness, ie, greater food hardness generates an increased number of masticatory cycles, thereby increasing overall electromyographic activity and duration of masticatory movements. In the present study, reduced discomfort and increased denture stability after relining might have improved masticatory performance and frequency and resulted in masticatory cycles that were more regular and uniform (27).

Impact (total standardized electromyographic activity) during mastication was higher at T90 for all test foods. These results corroborate those of Zhang et al. (17) who reported increases in EMG and bite force during chewing after relining. However, Hayakawa et al. (18) found improvements in masticatory function, without differences in electromyographic activity, before and after relining. In a randomized controlled trial, Kimoto et al. (2) reported that use of a silicone-based soft liner improved masticatory performance by changing the occlusion phase during chewing; however, they found no change in electromyographic activity, which, according to the authors, might have been due to insufficient accuracy and sensitivity of the electromyographic evaluation to detect differences between conventional and relined dentures. In another study, Kimoto et al. (28) found that better masticatory performance and electromyographic activity were related to a longer duration of teeth in occlusion during the chewing cycle. It is likely that, due to denture discomfort, patients in the present study failed to occlude properly and uniformly during mastication at baseline, which may have resulted in lower electromyographic activity during the baseline EMG assessment.

The hard liner group had greater EMG activity than the soft liner group during wafer chewing only. A possible explanation for this result is that the wafer, a soft food, does not require much muscle effort during chewing; therefore little masticatory load is generated. Thus, the soft liner was able to absorb most of the masticatory load and stress, i.e., less muscle activity was produced, as compared with the hard denture liner.

The present study had limitations. According to Furuyama et al. (29), optimally designed studies are not always feasible. Group allocation was not randomized, so it is unwise to infer that differences or similarities between groups are attributable to the intervention (relining). Despite this limitation, we found no statistically significant difference between groups, especially in sociodemographic characteristics. The sample was homogeneous with respect to these characteristics, and the same group was analyzed before and after treatment (3). Moreover, the sample was representative of unsatisfied patients who present with similar complaints about their dentures (especially mandibular dentures) at teaching clinics in dental schools.

Another limitation was the follow-up period after relining (90 days). Although suitable for long-term use, the soft, silicone-based denture liner (Mucopren Soft) has drawbacks as compared with the hard, acrylic-based denture liner (Kooliner), such as increased uptake and loss of chemical compounds through the oral cavity (30) and poor adhesion to the denture base (10). These factors may not have been perceived by participants, due to the short duration of follow-up. A longer follow-up period might have yielded different electromyographic results (31).

Our findings suggest that dentists should inform their patients that denture relining is a good option for gradually improving masticatory function as well as denture stability, retention, and comfort (2). We believe that, in conjunction with a full functional assessment, our findings will assist dentists in selecting appropriate denture liners.

In conclusion, relining increased electromyographic activity of the masseter and temporal muscles and improved masticatory function. In addition, there was no significant difference between hard and soft denture liners for most electromyographic variables.

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