Masseter Muscle Thickness And Elasticity in Bruxism After Exercise Treatment: A Comparison Trial

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Abstract

Objective: The purpose of this study was to evaluate the effects of Rocabado's 6 × 6 exercises on masseter muscle thickness, muscle elasticity, and pain scores in patients with bruxism.

Methods: A total of 58 participants with bruxism were divided into 2 groups as the exercise group (EG) and control group (CG). A self-care program was applied for the participants in the CG. For those in the EG, in addition to the self-care program, an exercise treatment was performed for 6 days per week for a total of 8 weeks. Using ultrasonography, bilateral masseter muscle thickness and elasticity were assessed before and after treatment. Pain was measured using a visual analog scale. Changes over time within the groups and group−time interactions for continuous variables were assessed using mixed 2-way repeated measures analysis of variance.

Results: The improvement in muscle elasticity ($P = .015$; $P = .004$) and pain values ($P = .049$; $P = .040$) were greater in the EG compared with the CG. There was no significant difference between the 2 groups for masseter muscle thickness ($P > .05$).

Conclusion: This study suggests that Rocabado's 6 × 6 exercises are effective in the treatment of muscle elasticity and pain values in participants with bruxism. (J Manipulative Physiol Ther 2022;45;282-289)

Key Indexing Terms: *Masseter Muscle; Masticatory Muscles; Bruxism; Ultrasonography*

Introduction

Temporomandibular joint dysfunction (TMD) is a term that applies to problems that occur in the masticatory muscles, temporomandibular joint (TMJ), or both.[1] TMD can occur at any age; yet, it occurs most often in young adults.[1,2] It leads to pain in the jaw and surrounding tissues, restricted jaw movements, and crepitation.[2] The etiopathogenesis of TMD is multifactorial, and can include anxiety, stress, and other emotional disorders; occlusal causes such as malocclusion and hard bite; whiplash syndrome; inflammation caused by cytokines such as interleukin 1 beta and tumor necrosis factor alpha; hypermobility; female hormonal factors; and parafunctional habits.[3-6]

As a common parafunctional habit, bruxism is defined as an increased jaw activity caused by grinding and clenching the teeth and strong jaw movements.[7] These actions cause microtrauma in the TMJ or hyperactivity in the chewing muscles.[8] Bruxism can occur during day and/or night. Bruxism that occurs in the state of wakefulness, mainly involves involuntary jaw muscle contractions and clenching, and rarely rubbing teeth together and grinding.[6,7] Commonly seen in about 20% of the population, this type usually occurs in states of high tension and anxiety.[7] Nocturnal bruxism (NB), which occurs during sleep, is the most common type of bruxism and is classified as "sleep-related movement disorders" according to the International Classification of Sleep Disorders.[9,10] Rhythmic chewing muscle activity in high frequency and amplitude is observed in the majority of individuals with NB. In addition to abnormal wear on teeth surfaces due to grinding, at least one of the clinical conditions such as temporary pain and fatigue in jaw muscles, temporal headache, and jaw locking (trismus) is present in individuals with NB.[9,10] This excessive load causes destruction in the periodontal ligament and distortion in the alveoli. The prevalence of NB is reported as 14% to 20% in children younger than 11 years of age, 13% in young adults, 5% to 8% in adults, and 3% in people over 60.[11]

Treatment approaches mainly aim to reduce symptoms by addressing contributing factors, decreasing pain, and

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Paper submitted July 21, 2020; in revised form April 4, 2022; accepted July 14, 2022.
0161-4754

https://doi.org/10.1016/j.jmpt.2022.07.004

restoring normal strength, length, function, and coordination of the muscles.[12-17] Medications, self-care (SC), cognitive-behavioral interventions, trigger-point injections, physical therapy modalities, massage, intraoral splints, alternative medicine techniques, and exercises are among different treatment modalities for bruxism.[12-17] To decrease pain, improve masticatory muscle functions, and correct forward posture of head, a 6 × 6 exercise program was introduced by Rocabado to be applied in combination with the SC program.[18] The objectives of the Rocabado program include learning a new postural position, restoring original muscle length and stiffness, normal joint mobility, and body balance.[18] Clinical use of the 6 × 6 program is reported in the TMD literature, both as a group program and as an individual intervention. Several clinical trials have investigated the effects of the 6 × 6 program on TMD and/or posture; however, evidence is still lacking to support the efficacy of these exercises for the treatment of bruxism.[19-21] Therefore, the purpose of the present study was to investigate the effect of the 6 × 6 exercises on masseter muscle thickness, muscle elasticity, and pain scores in individuals with bruxism. As the hypothesis of the study, it was predicted that these exercises could have therapeutic effects on the related parameters. In such case, these exercises could be added to the rehabilitation program to increase the functional capacity of patients with bruxism.

Methods

Study Design

This study was a nonrandomized comparison trial. A total of 58 participants were divided into 2 groups as the exercise group (EG, n = 29) and control group (CG, n = 29). An SC program was applied for the participants in the CG. In addition to this program, Rocabado's 6 × 6 exercises were administered for the EG. The treatment sessions were administered by the same investigator (İ.U.). Both pre- and post-treatment evaluations of all participants were made by the same investigators (C.K., Y.D.).

Blinding Procedure

A medical doctor experienced in managing TMJ disorders referred the participants to a physiotherapist, and a radiologist performed baseline ultrasonographic assessments. The relevant questionnaires and tests were completed. Both the radiologist and physiotherapist were blind to the study. After the treatment, all participants were reexamined by the same investigators who had conducted the initial examinations. The same procedures and record forms were used for both pre- and post-treatment assessments.

Participants

A total of 58 adults with bruxism who were admitted to the Physical Medicine and Rehabilitation Outpatient Clinic were included in the study. Inclusion criteria were set as presence of bruxism for at least 6 months, having a minimum of a 40-mm pain score in the masticatory muscles during the previous month, ability to comprehend and follow verbal instructions, being between 18 and 65 years of age, and volunteering to participate in the study.[22-26] The exclusion criteria were set as presence of systemic rheumatic disease and fibromyalgia, dental pathology, orofacial pain disorders, TMJ disc displacement without reduction or osteoarthritis as determined by history and clinical examination, cervical structural pathology as determined by history and physical examination using a cervical range of motion goniometer, current intake of over-the-counter analgesics for more than 3 days per week, and current use of narcotics, hypnotic drugs, sedatives, or muscle relaxants. If participants were taking antidepressant or antianxiety medications, they were required to be on a stable dose for the preceding 2 months. Participants with a concurrent major psychiatric disease or participants unwilling to participate were excluded from the study.[22-26]

Ethics

This study was approved by the Kırşehir Ahi Evran University Medical Faculty Clinical Research Ethics Committee. Before the study, written and verbal consent was obtained from all participants, and the study was conducted in accordance with the Declaration of Helsinki.

Evaluation Methods

Sociodemographic data of all individuals were recorded. Some of the assessment methods were administered upon the patients' visit to the doctor. These included a bruxism questionnaire, clinical evaluation, signs, and symptoms.[27-33]

Bruxism Questionnaire

Noise may or may not accompany bruxism; thus, most individuals might not be aware of their bruxism. For a subjective assessment, the bruxism questionnaire was used. The questions were as follows: (1) Has anyone heard you grinding your teeth during the night? (2) Do you ever have a headache in the morning? (3) Have you ever noticed that you clench or grind your teeth during the day? (4) Do you ever feel your jaw being fatigued or sore on awakening in the morning? (5) Have you ever felt soreness in your teeth or gums on awakening in the morning?[31]

Clinical Evaluation

The diagnosis of bruxism included evaluating tooth mobility and wear, as well as other clinical findings of

TMJ. These included (1) presence of tooth wear in normal and eccentric jaw movements, (2) tooth/teeth hypersensitivity to cold, (3) clicking or locking of TMJ, and (4) complaint of morning discomfort, fatigue, or stiffness in the masticatory muscles.[32,33]

Signs and Symptoms

Signs and symptoms used for the diagnosis of bruxism included pain in the teeth and sensitivity to heat and cold; chronic muscular facial pain together with tension headaches caused by intense muscle contraction; teeth-grinding noise noticed by others; abnormal teeth alignment due to uneven tooth wear; broken or chipped teeth; flattened and worn tooth surfaces that may reveal the underlying yellow dentine layer; microfractures in the tooth enamel; stiffness and pain in the jaw joint leading to limited opening and difficult chewing; earache; and damage in jaw joint that is slow to heal.[32,33]

Imaging Techniques

A linear probe (Toshiba Aplio 174 500; Toshiba, Nasu, Japan) was used for ultrasonographic imaging (4-11 MHz).[34,35] Bilateral imaging and measurements were performed with the participant sitting in an upright position without leaning on the head rest. The procedure involved 2 different conditions: (1) muscle in relaxation (ie, the teeth were occluding gently) and (2) muscle in contraction (ie, maximal clenching in the intercuspal position).[34,35] The measurement took place at the thickest part of the masseter muscle close to the level of the occlusal plane. It was ensured that the transducer was perpendicular to the mandibular ramus, since oblique scanning would cause a false increase in the muscle thickness values. In order to avoid tissue compression, a generous amount of gel was used underneath the probe. Imaging and measurements were performed twice, with a minimum of 5-min interval between the two. The mean of the 2 measurements was recorded as the muscle thickness per side. The measurements were directly taken from the scanning image with a read-out distance to the nearest 0.1 mm; then the scans were printed on film paper using a videocopy printer.[34,35]

Real-time sonographic elastography was performed with the linear probe for all participants.[36-38] They were asked to sit in an upright position with the head in a natural position. The masseter muscle was scanned bilaterally perpendicular to the anterior border of the muscle and to the surface of the underlying ramus at 15 mm above the inferior border of the mandible. A sonogram was taken with a focal range of 20 mm and an image depth of 50 mm.[36-38] The monitored compression was only 1 μm. The results were considered acceptable only if a pressure of 3 to 4 on a scale of 0 to 6 arbitrary units was applied. Using the strain and stress of the muscle, the muscle elasticity distribution was calculated. As the first step, the amount of displacement of the reflected ultrasound echoes with and without compression were measured (stress field). In a hard muscle, this displacement was small; whereas, in an elastic or soft muscle, it was large. In the second step, a strain field was constructed from the measured displacements (strain image). While areas with low elasticity appeared as fields of low strain, areas of high elasticity appeared as high strain fields.[36-38] Using a three-dimensional tissue model (finite-element method), the elasticity of the masseter muscle was determined based on the displacement of each element before and after compression. The calculation of muscle elasticity distribution was performed in real time and the examination results were represented as color-coded images with the conventional B-mode image in the background. Hard and soft muscles were expressed as blue and red, respectively. For statistical analysis, 4 levels were created according to the colors in the images as follows: (1) red, (2) mostly yellow, (3) mostly green, and (4) blue.[36-38]

Pain Severity

The visual analog scale (VAS) was used to assess the severity of pain in the masseter muscle at rest and during contraction. VAS provides a rapid (statistically measurable and reproducible) measurement of pain severity. The participants marked the severity of their pain on a 10-cm-long line (0 = no pain, 10 = the worst pain possible).[39]

Treatment Program

A self-care program was provided for both groups based on the following recommendations[40,41]:

1. *Reduce stress:* Listen to music and take a warm bath.
2. *Avoid stimulating substances in the evening:* Do not drink caffeinated coffee or tea after dinner and avoid alcohol during the evening, as they may worsen bruxism.
3. *Practice good sleep habits:* Get a good night's sleep.
4. *Talk to your sleep partner:* If you have a sleeping partner, ask him or her to be aware of any grinding or clicking sounds that you might make while sleeping so you can report this to your dentist or doctor.
5. *Schedule regular dental exams:* Additional contacts with the dentist could reinforce your motivation to treatment.

In addition to the SC program, Rocabado's 6 × 6 exercises were administered to the EG for 6 days per week for a total of 8 weeks. This program included 6 exercises—each with 6 repetitions—to be performed 6 times a day.[18] Supervised sessions were held on weekdays, and on Saturdays the participants performed the exercises as self--administered sessions at home. They were asked to

complete a logbook to document exercise compliance on Saturdays.

The participants received verbal and written explanations and instructions in an identical standardized manner from a physical therapist who trained the participants about their jaw muscle condition. The therapist ensured that the time spent with all participants was constant and equal.

The content of Rocabado's 6 × 6 exercises is as follows[18]:

1. *Rest position for the tongue:* To rest the tongue and jaw and to promote diaphragmatic breathing in order to decrease activity of the accessory muscles.
2. *Shoulder posture:* Shoulder girdle retraction to correct abnormal scapular protraction.
3. *Stabilized head flexion:* Distraction of the upper cervical spine to alleviate mechanical compressions; this leads to the elongation of the posterior cervical muscles.
4. *Axial extension of the neck:* Distraction of the cervical spine; this leads to tension reduction in the supra- and infrahyoid muscles and enhances the ability of the chewing muscles to relax. This exercise helps the sternocleidomastoid muscle take a more normal posterior angulation, thus reducing unnecessary muscle activity to maintain the position.
5. *Control of TMJ rotation:* Reducing translatory component when initiating jaw movements (ie, protrusive movement in mouth opening, talking, or chewing), which leads to a reduction in masticatory muscle activity and joint overload.
6. *Rhythmic stabilization technique:* Inducing muscle relaxation based on the principle of reciprocal inhibition. When a muscle is actively contracted, its antagonists are consequently relaxed. Rhythmic stabilization also enhances the proper jaw rest position through proprioception.

Sample Size

To the best of our knowledge, the effectiveness of Rocabado's 6 × 6 exercises on masseter muscle thickness and elasticity in bruxism has not been investigated to date. However, a previous study demonstrated that the 6 × 6 exercises were not more beneficial than self-care alone in reducing the intensity of jaw and neck pain in patients with masticatory myofascial pain ($P > .05$).[42] Therefore, with a statistically significance level of 5%, a statistical power of 80% using G*Power Software (version 3.1.9.2), and an effect size of 0.8, a minimum of 27 participants were required per group (a total of 54 participants). Allowing for a 10% drop-out rate, 60 participants were recruited into the study.

Statistical Analysis

The data were analyzed using the SPSS Statistics for Windows (version 20.0; IBM Corp, Armonk, NY). The Kolmogorov−Smirnov test was used to check normality. Values were expressed as the mean ± standard deviation for continuous variables, and frequencies were reported for categorical variables. The independent samples t test was used to compare the continuous variable between the 2 groups (age). The χ^2 test was used to compare the categorical variables between the 2 groups (sex and chewing side). The paired sample t test was used to determine the mean difference between pre- and post-treatment. Changes over time within the groups and group−time interactions for continuous variables were assessed using mixed 2-way repeated measures analysis of variance. The classification of effect sizes (f) was determined by calculating partial eta squared (f = 0.10 [small effects], f = 0.25 [medium effects], and f = 0.40 [large effects]).[43]

Results

Initially, 60 participants with bruxism were included in the study; however, 2 individuals dropped out. Hence, the study was completed with 29 participants in the EG and 29 in the CG.

Baseline characteristics of the participants are presented in Table 1. The 2 groups were similar in terms of their basic parameters ($P > .05$).

The improvement in muscle elasticity ($P = .015$; $P = .004$) and pain values ($P = .049$; $P = .040$) were greater in the EG compared with the CG. There was no significant difference between the 2 groups in terms of masseter muscle thickness ($P > .05$, Table 2).

Discussion

To the best of our knowledge, this is the first study to investigate efficacy of the 6 × 6 exercises in the treatment of bruxism. The results of our evaluations indicate that the 6 × 6 exercises were effective in improving masseter

Table 1. *Descriptive Characteristics of Groups*

	Control Group	Exercise Group	*P* Value
Age (y), mean ± SD	20.88 ± 0.32	21.66 ± 0.47	.056[a]
Sex (male/female), n (%)	17/9 (52.94%)	19/11 (57.89%)	.548[b]
Chewing side (right/left), n (%)	16/10 (62.5%)	23/7 (30.43%)	.175[b]

SD, standard deviation.
[a] Independent samples t test.
[b] χ^2 Test.

Table 2. *Group Means, Standard Deviations, and Ranges for Assessment Parameters, Between-Group Comparison, and Effect of Exercise*

	Control Group			Exercise Group			P^2 Value	
Outcome Measures	Baseline	After	P^1 Value	Baseline	After	P^1 Value	Time	Group × Time
Masseter muscle thickness (R)	8.69 ± 1.18	8.70 ± 1.21	.944	9.31 ± 1.17	9.25 ± 1.23	.244	.777 (.003)	.666 (.008)
Masseter muscle thickness (L)	9.02 ± 1.09	9.16 ± 1.17	.179	9.31 ± 1.49	9.28 ± 1.17	.608	.511 (.017)	.251 (.052)
Masseter muscle elasticity (R)	2.15 ± 0.73	2.23 ± 0.76	.564	3.11 ± 0.81	2.73 ± 0.45	.002	.014 (.282)	.015 (.213)
Masseter muscle elasticity (L)	2.30 ± 0.78	2.19 ± 0.63	.265	3.00 ± 0.80	2.61 ± 0.75	<.001	.001 (.342)	.004 (.286)
Pain at rest	4.21 ± 0.83	2.93 ± 0.48	<.001	4.03 ± 0.95	2.26 ± 0.53	<.001	.042 (.193)	.049 (.186)
Pain during contraction	5.63 ± 1.43	2.99 ± 1.59	<.001	5.76 ± 1.13	2.75 ± 1.01	<.001	.036 (.247)	.040 (.216)

Values are expressed as the mean ± standard deviation. Numbers in parentheses are effect sizes.
L, left; P^1, paired sample *t* test; P^2, 2-way repeated measures analysis of variance with a mixed model; *R*, right; *VAS*, visual analog scale.

elasticity in patients with bruxism. And, the results showed that these exercises can be used for relieving pain in this population.

According to the International Classification of Sleep Disorders from the American Academy of Sleep Medicine, NB is defined as a sleep-related movement disorder characterized by teeth clenching or grinding during sleep.[17] However, awake bruxism is semi-voluntary teeth clenching that is seldom audible.[17] Considering the high prevalence of bruxism, it is important to find an effective treatment method. Affecting millions of people around the world, bruxism is considered one of the most harmful activities for the stomatognathic system; primarily due to the associated morphologic, psychosocial, and pathophysiologic features and clinical consequences.[12,14] Commonly, muscle pain leads to muscle activity alterations, restrictions in jaw opening, stress, anxiety, depression, poor sleep, low quality of oral health, TMJ disorders, and postural alterations. Therefore, treatment of bruxism may require an interdisciplinary professional team including medical doctors, dentists, physiotherapists, and other providers (eg, chiropractors) who use exercise as part of their therapies.[12,14] The conservative approach is recommended for the management of bruxism.[17] A systematic review study reported very low-quality evidence for the diverse methods used in physical therapy to improve muscle pain and activity, oral health, mouth opening, stress, anxiety, depression, TMJ disorder, and head posture in individuals with bruxism. This finding is mainly associated with the poor methodological quality of most of the studies.[17] In the present study, ultrasonographic imaging was used as an objective assessment tool for the management of bruxism in young adults. In addition to the objective assessment, the design of the present study as a nonrandomized comparison trial adds to its strengths compared with previous studies in the relevant literature.[44-46]

As there were no similar studies related to Rocabado's 6 × 6 exercises as a possible exercise approach influencing masseter thickness and elasticity, our results are discussed in relation to studies investigating exercise treatments and masticatory activation in bruxism. Bulut et al[47] conducted a pilot study to examine the masticatory activation in patients with bruxism with and without attrition by ultrasonographic evaluation of mandibular adductor muscles. They reported that the thickness of chewing muscles increases in bruxism. The occlusal forces in the teeth increase and lead to an increase in tooth wear. Ultrasonographic muscle thickness can be used to determine muscle activity in patients with bruxism.[47] Our results regarding masseter muscle thickness are incompatible with this study,[47] in which the authors reported that there was a difference in muscle thickness between patients with bruxism and healthy individuals.[47]

Bite force has been considered an essential factor in the diagnosis of the conflicts in the stomatognathic system, as it reveals valuable information regarding jaw muscle function and activity.[48] In their study on patients with bruxism and healthy individuals, Capitanio et al[49] found no alterations in bite force and no statistical significance in the muscle activity studied in clinical conditions of rest and clenching in maximum contraction. Considering that there was no significant difference between the 2 groups in terms of masseter muscle thickness in the present study, our results are compatible with this study.[49]

Some studies have investigated various exercise methods in bruxism. Gouw et al[50] reported that static stretching of chewing muscles caused a slight increase in sleep bruxism episodes (not significant) and bursts (significant). It also caused a significant increase in maximum mouth opening and masseter pressure pain threshold. They concluded that in the absence of pain and/or dysfunction, masticatory muscle stretching was not effective in reducing sleep

bruxism.[50] Makino et al[42] studied the effects of exercise therapy on jaw movements and psychological intervention on parafunctional activities in patients with chronic pain in the craniocervical region. They reported that a combination of jaw exercise and psychological intervention is more effective than jaw exercise alone for the improvement of craniocervical pain without apparent organic abnormalities.[42] In our study, the improvement in muscle elasticity was greater in the BG compared with the CG. However, there was no significant difference between the 2 groups in terms of masseter muscle thickness. Absence of any difference in muscle thickness between the 2 groups may stem from the lack of a combination of exercise therapy and psychological intervention in our study.

Positive effects of exercise treatment on muscle flexibility have been reported in the literature.[51-54] In patients with bruxism, muscle pain, muscle activity alterations, and restrictions in mouth opening necessitate improving masseter muscle elasticity in this population. Although several clinical trials have been conducted to evaluate the effects of 6 × 6 program on TMD and/or posture, evidence is still lacking on the efficacy of these exercises in the treatment of bruxism.[19-21] According to our results, the 6 × 6 program seems to be effective in improving masseter muscle elasticity in patients with bruxism. These findings may be beneficial for clinicians and researchers in TMJ rehabilitation to facilitate clinical decision-making directed to improve functional outcomes.

As a common complaint of the patients with bruxism, orofacial pain is frequently related to TMJ or masticatory muscles.[55] Conti et al[55] evaluated the sensitivity and precision of 4 different pain rating scales in 59 patients with temporomandibular disorders. These scales were VAS, Numerical Scale, Behavior Rating Scale, and Verbal Scale. The capacity of the scales in describing symptom changes during treatment also was studied. The participants were asked to answer all 4 pain scales. The researchers concluded that all scales demonstrated 30% to 50% symptom decrease in a period of 6 months.[55] We used the VAS to assess the severity of pain in masseter muscle during rest and contraction. For the EG, the mean VAS score at rest was 4.03 and 2.26 points before and after the treatment, respectively, representing an improvement of 43.92%. The mean score during contraction was 5.76 and 2.75 points before and after the treatment, respectively, indicating an improvement of 52.25%. In terms of pain values, the current study is compatible with the study by Conti et al.[55]

Limitations

Although the age range of the participants was determined as young adults, the average age of the participants in this study was approximately 21 years. It is recommended that future studies regroup the participants based on their age in intervals of years. This can help with overall availability and generalization of the results. Second, as the study group included individuals with bruxism, the results of the study cannot be interpreted for other TMJ pathologies.

Conclusion

Our study suggests that the 6 × 6 exercises were effective in the treatment of masseter elasticity deficiency in patients with bruxism. The results showed that these exercises relieved pain in these patients. These findings may be useful for clinicians and researchers in bruxism rehabilitation to facilitate clinical decision-making to improve masseter muscle performance.

Funding Sources and Conflicts Of Interest

No funding sources or conflicts of interest were reported for this study.

Contributorship Information

Concept development (provided idea for the research): İ.U., Y.D., C.K., A.Ö., M.O.
Design (planned the methods to generate the results): İ.U., Y.D., C.K.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): İ.U., Y.D., C.K., A.Ö.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data):İ.U., C.K., Y.D., M.O.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): İ.U., C.K., Biostatistics Specialist
Literature search (performed the literature search): İ.U., Y.D., C.K., A.Ö., M.O.
Writing (responsible for writing a substantive part of the manuscript): İ.U., C.K.
Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): İ.U., Y.D., C.K., A.Ö., M.O., Native Speaker

Practical Applications

- The 6 × 6 exercises were beneficial in the treatment of masseter elasticity deficiency in patients with bruxism.
- These exercises may be useful when considering management for relieving pain in this population.

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