

COMPARISON OF KINESIO TAPING AND MANUAL THERAPY IN TREATMENT OF PATIENTS WITH BRUXISM USING SHEARWAVE ULTRASONOGRAPHY-A RANDOMIZED CLINICAL TRIAL

Melek Volkan-Yazici¹, Mehmet Eray Kolsuz², Nihan Kafa³, Gokhan Yazici³, Cengiz Evli², and Kaan Orhan²

¹Yuksekk Ihtisas Universitesi

²Ankara University Faculty of Dentistry

³Gazi University

February 5, 2021

Abstract

Background: Bruxism is significantly associated with craniofacial pain, feeling of stiffness or fatigue of the jaw and neck pain. Various physiotherapeutic strategies are used in the treatment of bruxism, however, it is not clear which method leads to greater decrease in pain. **Objective:** The aim of this study is to compare the effects of two physiotherapy methods (manual therapy (MT) and Kinesio taping with manual therapy (KTMT)) in patients with bruxism. **Methods:** Patients were randomized into MT or KTMT groups. Evaluations were performed at baseline and following four weeks of physiotherapy. Muscle thickness and stiffness were assessed via shearwave ultrasonography; pain thresholds were evaluated using algometer. Sleep quality was assessed using Pittsburgh Sleep Quality Index and Quality of life was assessed with Likert scales regarding the associated symptoms. **Results:** Significant improvements were found in muscle stiffness, pain threshold, sleep quality, quality of life ($p < 0.05$) in both MT and KTMT group. Pain in bilateral temporalis and right occipital region of the trapezius muscle decreased more in the KTMT group compared to the MT group ($p < 0.05$). No significant differences in muscle thickness ($p > 0.05$) were found in either of the groups. **Conclusion:** Both MT and KTMT methods were effective in the treatment of bruxism. KT used in conjunction with MT has additionally decreased jaw pain and temporal region pain when compared to MT intervention only. Therefore, if jaw pain is the primary complaint of a patient, our results recommend including KT application in the physiotherapeutic treatment program.

COMPARISON OF KINESIO TAPING AND MANUAL THERAPY IN TREATMENT OF PATIENTS WITH BRUXISM USING SHEARWAVE ULTRASONOGRAPHY-A RANDOMIZED CLINICAL TRIAL

ABSTRACT

Background: Bruxism is significantly associated with craniofacial pain, feeling of stiffness or fatigue of the jaw and neck pain. Various physiotherapeutic strategies are used in the treatment of bruxism, however, it is not clear which method leads to greater decrease in pain.

Objective: The aim of this study is to compare the effects of two physiotherapy methods (manual therapy (MT) and Kinesio taping with manual therapy (KTMT)) in patients with bruxism.

Methods: Patients were randomized into MT or KTMT groups. Evaluations were performed at baseline and following four weeks of physiotherapy. Muscle thickness and stiffness were assessed via shearwave

ultrasonography; pain thresholds were evaluated using algometer. Sleep quality was assessed using Pittsburgh Sleep Quality Index and Quality of life was assessed with Likert scales regarding the associated symptoms.

Results: Significant improvements were found in muscle stiffness, pain threshold, sleep quality, quality of life ($p < 0.05$) in both MT and KTMT group. Pain in bilateral temporalis and right occipital region of the trapezius muscle decreased more in the KTMT group compared to the MT group ($p < 0.05$). No significant differences in muscle thickness ($p > 0.05$) were found in either of the groups.

Conclusion: Both MT and KTMT methods were effective in the treatment of bruxism. KT used in conjunction with MT has additionally decreased jaw pain and temporal region pain when compared to MT intervention only. Therefore, if jaw pain is the primary complaint of a patient, our results recommend including KT application in the physiotherapeutic treatment program.

KEYWORDS: Bruxism, Pain, Manual Therapy, Kinesio Taping, Physiotherapy, Rehabilitation

The study was registered on clinicaltrials.gov with an ID of NCT 04363931.

What is already known about this topic?: There is no certain treatment for Bruxism. However, the most recent recommendation is to follow an approach prior consisting of; physiotherapy, plates, pep talk, pills and psychology. However, literature regarding which intervention is the most effective in bruxism is not clear.

What does this article add?: Following treatment with manual therapy and Kinesio taping, Significant improvements were found in muscle stiffness, pain threshold, sleep quality, quality of life in patients with Bruxism. If jaw pain is the primary complaint of a patient, our results recommend including Kinesio Taping application in the physiotherapeutic treatment program.

INTRODUCTION

Bruxism is defined as a repetitive jaw muscle activity characterized by tooth grinding or clenching accompanied with wearing of the teeth, and jaw muscle discomfort in the absence of a medical disorder. Bruxism has two distinct circadian manifestations: it can occur during the day or during sleep and is defined as awake bruxism or sleep bruxism respectively [1]. The etiology of bruxism is not totally clear however, some etiologic factors are; personality characteristics and psychosocial factors such as stress and central factors [2].

Bruxism leads to many negative outcomes affecting the muscles, such as inflammation, chronic local muscular contracture and localized muscular hypertrophy, which may in turn cause myofascial pain [3]. One of the most affected muscles due to bruxism is the masseter, the muscle that elevates the mandible [4]. Hypertrophy of the masseter muscle is an objective sign of bruxism. Additionally, fatigue or stiffness in the masticatory muscles, pain in the temporomandibular joint or headaches are subjective signs of bruxism. According to the literature, the vast majority of the general population experience episodes of bruxism during their lives. Thus, finding an effective treatment method for bruxism is crucial [5].

There is no certain treatment for Bruxism. However, the most recent recommendation is to follow the Multiple-P approach prior to medical drug regimens and invasive procedures. Different methods used in the conservative management of bruxism are known as the multiple-P approach; physiotherapy, plates, pep talk, pills and psychology [6]. Physiotherapy generally focuses on two objectives: decreasing the adverse effects of bruxism to the masticatory muscles and increasing self-awareness regarding this habit. These studies involve different interventions such as massage of the masticatory and cervical muscles, electrotherapy, therapeutic exercises, taping interventions or relaxation therapies [7]. Manual Therapy (MT) is a widely used physiotherapy modality which is known to be effective in the management of musculoskeletal problems [8]. MT is a passive, therapeutic approach used to target a variety of anatomical structures with the intent to create beneficial changes in the amount of pain a patient experiences. MT includes mobilization, manipulation, and treatment of the soft tissues or joints and is widely used to break fibrous adhesions, restore normal range of motion, reduce local ischemia, stimulate synovial fluid production, and reduce pain [9]. Another passive intervention used in physiotherapy is the Kinesio² taping method. Kinesio Tape (KT)

is a type of elastic therapeutic tape that was developed by Dr. Kenzo Kase and is used in many different situations with various aims. Advocates of KT state that it may promote different therapeutic objectives such as; improved circulation and lymphatic drainage, pain inhibition, reduction of delayed onset of muscle soreness or improvement in performance and coordination [10-12]. However, literature regarding which physiotherapy intervention is the most effective in bruxism is not clear. More clinical trials are necessary to clarify the effectiveness of different interventions.

Studies evaluating muscle thickness using Ultrasonography (US) [13, 14] and muscle thickness/width and cross-sectional area using Computed tomography [15, 16] have been conducted to assess changes in masseter morphology associated with orthognathic surgery. Although the muscle stiffness meter has been validated as a reliable method for evaluating muscle stiffness in the clinical setting, it only provides stiffness at certain points on the muscle [17, 18]. Ultrasound elastography is an imaging modality based on tissue stiffness or hardness, which is analogous to clinical palpation with ultrasonography for a malignancy. Unlike a physical examination, which allows only the subjective judgment of the stiffness of a lesion, elastography has the potential to quantify stiffness [19].

There are two elastographic techniques available as; strain and shear-wave elastography (SWE). Strain elastography produces an image based on the relative displacement of the tissue with manual compression of the transducer. The limitation of the strain technique is that the free hand probe pressure is difficult to standardize and the strain variations due to changes in the amplitude and velocity of compression that cannot be avoided. Meanwhile, SWE using the acoustic radiation force induced by the ultrasound push pulse generated by the transducer provides quantitative elasticity parameters, as well as displaying a visual color overlay of elastic information in real time [20].

In recent years, the ultrasound elastography (USE) has also been used to evaluate muscle stiffness and it was stated that the elasticity index (EI) ratio is a reliable method for determining masseter muscle stiffness [21, 22]. However, to the best of our knowledge, SWE has not been applied to follow-up treatment of masseter muscle changes.

Therefore, the purpose of this study was to compare the results of two different treatment modalities (Manual therapy intervention and Manual therapy plus Kinesio Taping Intervention) in patients with bruxism using shearwave ultrasonography (SWE).

MATERIALS AND METHODS

This study is a randomized clinical trial comparing the results of two physiotherapy interventions. Participants who were admitted to XXX University Faculty of Dentistry and were diagnosed with bruxism by a diagnostic dentist were included in the study. The inclusion criteria were set as: being older than 18 years of age and having a diagnosis of bruxism. Exclusion criteria were: the absence of more than two molar teeth; using removable partial dentures; having neurological, psychiatric or systemic diseases; alcohol and drug addiction; ongoing dental or physical therapy; the use of an occlusal splint during assessment; pregnancy; active cancer; or planned surgical procedures. Patients were also excluded if they had problems with their molar teeth, such as pericoronitis or supra eruption, and if they had been treated for temporomandibular joint disorder in the last three months. Informed consent forms were obtained from the subjects stating that they were willing to participate in the study. This study was approved by the ethical committee of XXX University (with the approval number of: 2019-348)), and the authors conformed to the ethical guidelines of the 1975 Declaration of Helsinki.

Study design

The study was planned as a randomized clinical trial and the randomization was performed by using an internet-based method (randomizer.org) by a dentist blind to the study groups. Forty-one patients with bruxism were assessed for eligibility. Nine patients did not want to participate in the study. Thirty-two patients were randomized into two groups: Manual Therapy (MT) group and Kinesio² Taping plus Manual Therapy (KTMT) group. The study was completed with 32 patients with bruxism. No patients were lost

prior to follow-up.

Outcome Measures

All patients who agreed to participate were assessed at baseline and following four weeks of physiotherapy interventions. Assessments were performed by a dentist blinded to the study. The demographic data as age; gender, weight and height were recorded.

Ultrasound Muscle Thickness Evaluation

Ultrasound imaging was performed by using a high resolution ACUSON S 2000 ultrasound machine (Siemens, Munich, Germany) with a 9L4 Linear Transducer. Measurements and analyses were performed by a single radiologist with eight years of experience. Bilateral masseter muscles were assessed in the resting position. During the USG procedure, the head of the patients was adjusted according to the measured side. While imaging, the probe was held perpendicular to the muscle mass and the anterior-posterior direction thickness and muscle volume were measured in transverse sections. Muscle thickness was measured from three different points of the masseter muscle and the average of the three measurements was taken and stored in USG machine pacs system for further analysis.

Ultrasound Elastography Muscle Stiffness Evaluation

Using the same transducer and strain elastography feature of the ACUSON S 2000 USG machine real-time two-dimensional (2D) elastography images were obtained at rest and in closed mouth position by the same radiologist. Muscle stiffness was measured with SWE which provides a semitransparent color-coded image displaying the shear wave velocity (m/sec) from ten different points of the masseter muscle and the average of the ten measurements was taken and analyzed.

Pressure Pain Threshold

Pressure Pain Threshold (PPT) was determined using a digital algometer (Lafayette Manual Muscle Test System, Model 01163, Lafayette Instrument Company, Indiana, USA) which consists of a padded disc attached to a microprocessor control unit that measures peak force (Newton). The PPT of the masseter, trapezius (anterior, posterior, occipital) and temporalis muscles was assessed via the algometer. During PPT assessment, the researcher positioned the algometer on the trigger points of the respective muscles and increase the amount of pressure applied until the participant verbally informed the researcher when the sensation of pressure became pain. The applied pressure was read from the digital screen after each assessment. A lower score indicates a lower pain threshold whereas, a higher score indicates a higher pain threshold.

Sleep Quality

The Pittsburgh Sleep Quality Index (PSQI) is an index widely used to measure sleep quality. The PSQI is a self-reported questionnaire that includes 19 questions that when scored, are separated into seven domains. The seven domains are; perceived sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, sleep medications; and daytime dysfunction. Each domain is scored from 0-3 and a total score ranging from 0-21 can be obtained. A total score of; 0-4 indicates a good sleep quality, 5-10 indicates poor sleep quality and scores above 10 indicate a possible sleep disorder. This index has been translated to Turkish and validated by Agargun et al [23].

Quality of Life

The factors associated with bruxism which caused problems in the daily life were assessed via Likert scales formed by the researchers. The Likert scales consisted of the following six identified problems; jaw pain, earache, headache, feeling tense, feeling depressed, difficulties in chewing. The problems were scored on a 5-point (0-4) scale as; 0: none, 1: mild, 2: moderate, 3: severe, 4: very severe [24].

Intervention

Following baseline assessments, all participants received information about symptoms and the process of bruxism. The patients in both groups were assessed in the same order, at baseline and following four weeks of physiotherapy intervention by the same researchers. In both groups, physiotherapy applications were applied two sessions a week for four weeks with each session lasting for 30 minutes.

Manual Therapy group

Manual Therapy (MT) applied on the masticatory muscles intra and extra orally alongside MT of the cervical region were used in treatment of bruxism. MT brings about benefits by increasing local circulation and decreasing muscle tonus. Additionally, stretching exercises aiming to decrease pain and elongate shortened masticatory muscle fibers by autogenic inhibition of the masseter muscle were also applied. Extra-oral applications consisted of; emphasis on the masseter and temporalis muscle using kneading, friction (performed in the direction of muscle fiber orientation), intramuscular stretching, sliding and ischemic compression for trigger point release. Myofascial release techniques were used to eliminate pain. Additionally, active and passive exercises were applied on the masseter, temporalis, digastric, medial pterygoid and lateral pterygoid muscles. Intra-oral applications consisted of; emphasis on the masseter muscles using kneading, friction (performed in the direction of muscle fiber orientation), intramuscular stretching and sliding, and ischemic compression for trigger point release. Applications of the cervical region consisted of; upper cervical flexion mobilization, C2-C5 central posterior-anterior mobilization, and also kneading, friction (performed in the direction of muscle fiber orientation), intramuscular stretching and sliding maneuvers for the cervical muscles [25]. MT was performed by a physiotherapist certified in MT.

Kinesio Tape plus Manual Therapy group

The material used for bruxism KT application was Kinesio Tex Gold Finger Prints (Kinesio Holding Corporation, Albuquerque, NM, USA), a 100% cotton, latex-free, 5-cm wide, elastic tape. KT placement was chosen according to principles described by Kase et al. Tapes were cut 2.5 cm in width (cut in half vertically from 5 cm width). Two strips of KT were crossed over the masseter muscle area with 0-5% tension in maximum stretched epidermis position. Web-cut strips EDF (epidermis-dermis-fascia) technique were used. Tape was applied bilaterally after every session of MT and the tape was removed one day before the next MT session. EDF taping for KT procedure was completed according to Kenzo Kase's KT manual by a certified physiotherapist [26].

Statistical Analyses

Statistical analyses of the study were carried out with "statistical package for social sciences" (SPSS) version 21.0 (SPSS INC., Chicago, IL, USA) software. Categorical variables were noted in frequency and percentage. The normal distribution of the data was analyzed with visual (histogram and probability graphs) and analytical (Shapiro-Wilk test) methods. The Wilcoxon test was used to compare the change between before and after treatment. Mann-Whitney U test was used for analyzing the variance between the groups because the variables did not have a normal distribution. The level of significance was set at $p < 0.05$ [27].

RESULTS

A total of 32 participants were randomly allocated to MT (n=16) or KTMT (n=16) groups. The age and gender distributions of the participants in the MT (15 females, one male) and KTMT (15 females, one male) groups were homogeneous. The mean age of the participants in the MT and KTMT groups were; $24,6 \pm 3,9$ and $25,3 \pm 4,1$ respectively.

The average thickness measurements taken before and after treatment of the bilateral masseter muscles were calculated and analyzed within each group. No significant differences in muscle thickness ($p > 0.05$, Table 1) were found in the assessments performed before and after treatment in either of the groups. The average stiffness measurements taken before and after treatment of the bilateral masseter muscles were calculated and analyzed within each group. Significant differences were found in muscle stiffness ($p < 0.05$, Table 1) in the assessments performed before and after treatment in both the MT and the KTMT group. When the

amount of change in stiffness measurements were compared; it was seen that the change was statistically similar in both groups ($p>0.05$, Table 1).

PLEASE INSERT TABLE 1 AROUND HERE.

When the PPT measurements were analyzed, it was seen that significant improvements were seen in 5 of the 10 trigger points ($p<0.05$, Table 2) in the before and after assessments of the MT group. In 5 of 10 trigger points no statistically significant difference was found ($p>0.05$, Table 2) in the before and after assessments of the MT group. However, when the PPT measurements of the KTMT group were analyzed, it was seen that significant improvements were seen in eight of the 10 trigger points ($p<0.05$, Table 2) in the before and after assessments of the KTMT group. In 2 of 10 trigger points no statistically significant difference was found ($p>0.05$, Table 2) in the before and after assessments of the KTMT group. When the amount of change in PPT measurements were compared; It was observed that the PPT of the right and left temporalis muscles and right occipital region of the trapezius muscle increased more in KTMT group compared to the MT group. It was seen that the change in other muscles was statistically similar in both groups ($p>0.05$, Table 2).

PLEASE INSERT TABLE 2 AROUND HERE.

The total PSQI scores measured before and after treatment were calculated and analyzed within each group. Significant differences were found in PSQI ($p<0.05$, Table 3) in the assessments performed before and after treatment in both the MT and the KTMT group. When the amount of change in total PSQI scores were compared; it was seen that the change was statistically similar in both groups ($p>0.05$, Table 3).

PLEASE INSERT TABLE 3 AROUND HERE.

According to the Quality of Life scores measured within groups, before and after treatment, it was seen that significant improvements were found in all of the sub-scales in both groups ($p<0.05$, Table 4). When the amount of change in total PSQI scores were compared; it was observed that jaw pain decreased more in the KTMT group compared to the MT group and it was seen that the change in other subscales was statistically similar in both groups ($p>0.05$, Table 4).

PLEASE INSERT TABLE 4 AROUND HERE.

DISCUSSION

This randomized controlled trial provided evidence regarding the effects of MT and KTMT interventions on muscle thickness, muscle stiffness, pain, sleep quality, and quality of life in patients with bruxism. The results showed significant improvement in muscle stiffness, pain, sleep quality and quality of life following a 4-weeks MT and KTMT physiotherapy program.

To date, there are only a few studies investigating the effect of MT applied to the masticatory muscles and cervical muscles in bruxism. Even though studies focusing on the effects of massage therapy in patients with bruxism can be found in literature, massage and MT differ in many aspects; massage therapy is the use of rhythmically applied pressure to the skin and soft tissues of the body. Massage therapy is used to reduce tension, anxiety, stress, and promote overall circulation, relaxation and flexibility. However, MT is the application of hands-on techniques to body tissues with the intent to therapeutically treat these tissues. MT techniques include soft tissue mobilization, myofascial release, strain-counter strain, muscle energy techniques, joint mobilizations and manipulations and mobilization with movement. MT techniques are utilized to enhance the healing process and correct positional faults of irritated tissues. Therefore, the results of our study were not discussed with the results of studies focusing on massage therapy in bruxism.

The current study included the application of MT on the masticatory muscles and cervical muscles. The cervical muscles were included in MT due to the nature of masseter and temporal muscle hyperactivity bringing about headaches and neck pain in patients with bruxism [28, 29] and it could be seen that there was a decrease in headaches in both groups.

When literature is examined there is a pilot study investigating the results of osteopathic MT in six patients with bruxism. Even though the utilized MT techniques are not the same, the researchers concluded that that osteopathic MT treatment may help patients with bruxism by reducing their perceived pain and stress levels [30]. Similarly, a case study was published by Knutson, G., which reports the results of MT in a six-year-old child. MT was applied on the upper cervical spine and following treatment the patient had reported a cessation of pain and sleep bruxing activity [31]. These findings are consistent with our study. The results of our study suggest that the use of MT as an initial treatment brings about a decrease in masseter muscle stiffness and pain perception, and an increase in sleep quality and quality of life. Our results put forth that MT is a beneficial intervention that could potentially be useful in the treatment of patients with bruxism.

In literature studies with KT application in patients with bruxism are present. Keskinruzgar et al., [32] compared the effects of KT with occlusal splints and concluded that KT was an easy-to-use treatment method for bruxism and was found to significantly reduce muscle pain and increase mouth opening in patients with Bruxism. Likewise, in the study by Rathi et al. [33], KT application had significantly improved pain and masseter muscle activity in individuals with Bruxism. The authors concluded that KT can be used along with other therapy methods to manage symptoms of Bruxism. Our results are in line with the results of these studies. In this study we have applied KT in addition to MT. It can be seen that KT has brought about further positive effects when applied in conjunction with MT. In patients in the KTMT group it was observed that jaw pain decreased, and pain in bilateral temporalis and right occipital region of the trapezius muscle decreased more in the KTMT group compared to the MT group. Previous studies have shown that following KT application, circulation increases due to an increase in epidermal-dermal distance and thus edema and inflammation decrease underneath the application region [34]. Therefore, the additional effects of KT may have occurred due to the local circulatory increase taking place underneath the applied tape. In our study, KT used in conjunction with MT has shown to lead to further improvements and therefore, in patients with bruxism whose primary complaint is jaw pain, applying KT on the masseter muscle in addition to MT may bear further benefits.

This study was not the first to utilize MT however, it was the first randomized clinical trial assessing the effects of MT and, KT used in conjunction with MT.

There are some limitations of the present study. The lack of a control group made it difficult for comparative analysis however, the authors have found it to be unethical to not provide patients with a treatment and therefore this study lacks a control group. Additionally, the effects of these interventions were not compared with the use of occlusal splints which are a widely used treatment modality in bruxism. Furthermore, this study only provides the short-term effects of MT and KTMT in patients with bruxism and long-term effects in larger groups should be investigated to draw definite conclusions.

CONCLUSION

The results of this study show that both MT and KTMT were effective physiotherapy modalities in the treatment of bruxism. KT used in conjunction with MT has shown to additionally decrease jaw pain and temporal region pain when compared to MT intervention only. Therefore, if jaw pain is the primary complaint of a patient applying to the clinic with bruxism, the results of this study recommend including KT application in the physiotherapeutic treatment program.

REFERENCES

1. Lobbezoo F, Ahlberg J, Raphael K et al. International consensus on the assessment of bruxism: Report of a work in progress. *Journal of oral rehabilitation* 2018; **45** : 837-44.
2. Lewis N. Book Review: *Bruxism: Theory and Practice*. SAGE Publications Sage UK: London, England 2011.
3. Jimenez-Silva A, Pena-Duran C, Tobar-Reyes J, Frugone-Zambra R. Sleep and awake bruxism in adults and its relationship with temporomandibular disorders: A systematic review from 2003 to 2014. *Acta Odontol Scand* 2017; **75** : 36-58.

4. Garip H, Tufekcioglu S, Kaya E. Changes in the temporomandibular joint disc and temporal and masseter muscles secondary to bruxism in Turkish patients. *Saudi Med J* 2018; **39** : 81-5.
5. Koyano K, Tsukiyama Y, Ichiki R, Kuwata T. Assessment of bruxism in the clinic. *J Oral Rehabil* 2008; **35** : 495-508.
6. Manfredini D, Ahlberg J, Winocur E, Lobbezoo F. Management of sleep bruxism in adults: a qualitative systematic literature review. *J Oral Rehabil* 2015; **42** : 862-74.
7. Amorim CSM, Espirito Santo AS, Sommer M, Marques AP. Effect of Physical Therapy in Bruxism Treatment: A Systematic Review. *J Manipulative Physiol Ther* 2018; **41** : 389-404.
8. Bishop MD, Torres-Cueco R, Gay CW et al. What effect can manual therapy have on a patient's pain experience? *Pain Manag* 2015;**5** : 455-64.
9. Miller J, Gross A, D'Sylva J et al. Manual therapy and exercise for neck pain: a systematic review. *Man Ther* 2010; **15** : 334-54.
10. Bravi R, Cohen EJ, Quarta E et al. Effect of Direction and Tension of Kinesio Taping Application on Sensorimotor Coordination. *Int J Sports Med* 2016; **37** : 909-14.
11. Csapo R, Alegre LM. Effects of Kinesio((R)) taping on skeletal muscle strength-A meta-analysis of current evidence. *J Sci Med Sport* 2015; **18** : 450-6.
12. Kalron A, Bar-Sela S. A systematic review of the effectiveness of Kinesio Taping—fact or fashion? *Eur J Phys Rehabil Med* 2013;**49** : 699-709.
13. Trawitzki LV, Dantas RO, Elias-Júnior J, Mello-Filho FV. Masseter muscle thickness three years after surgical correction of class III dentofacial deformity. *Archives of oral biology* 2011;**56** : 799-803.
14. Trawitzki LV, Dantas RO, Mello-Filho FV, Elias-Júnior J. Effect of treatment of dentofacial deformity on masseter muscle thickness. *Archives of oral biology* 2006; **51** : 1086-92.
15. Ueki K, Okabe K, Mukozawa A et al. Assessment of ramus, condyle, masseter muscle, and occlusal force before and after sagittal split ramus osteotomy in patients with mandibular prognathism. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* 2009; **108** : 679-86.
16. Katsumata A, Fujishita M, Ariji Y et al. 3D CT evaluation of masseter muscle morphology after setback osteotomy for mandibular prognathism. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* 2004; **98** : 461-70.
17. Hiraiwa Y, Ariji Y, Kise Y et al. Efficacy of massage treatment technique in masseter muscle hardness: robotic experimental approach. *CRANIO®* 2013; **31** : 291-9.
18. Kashima K, Igawa K, Maeda S, Sakoda S. Analysis of muscle hardness in patients with masticatory myofascial pain. *Journal of oral and maxillofacial surgery* 2006; **64** : 175-9.
19. Piccoli CW, Forsberg F. Advanced ultrasound techniques for breast imaging. *Semin Roentgenol* 2011; **46** : 60-7.
20. Youk JH, Son EJ, Gweon HM et al. Comparison of strain and shear wave elastography for the differentiation of benign from malignant breast lesions, combined with B-mode ultrasonography: qualitative and quantitative assessments. *Ultrasound Med Biol* 2014; **40** : 2336-44.
21. Ariji Y, Gotoh A, Hiraiwa Y et al. Sonographic elastography for evaluation of masseter muscle hardness. *Oral Radiology* 2013;**29** : 64-9.
22. Gotoh A, Ariji Y, Hasegawa T et al. Sonographic elastography for assessing changes in masseter muscle elasticity after low-level static contraction. *Oral Radiology* 2013; **29** : 140-5.

23. Ağargün MY, Kara H, Anlar Ö. The validity and reliability of the Pittsburgh Sleep Quality Index. *Türk Psikiyatri Derg* 1996;**7** : 107-15.

24. Joshi A, Kale S, Chandel S, Pal DK. Likert scale: Explored and explained. *British Journal of Applied Science & Technology* 2015;**7** : 396.

25. King HH, Jänig W, Patterson MM. The Science and Clinical Application of Manual Therapy E-Book: Elsevier Health Sciences 2010.

26. Kase K. Clinical therapeutic applications of the Kinesio (! R) taping method. *Albuquerque* 2003.

27. Kirkwood BR, Sterne JA. Essential medical statistics: John Wiley & Sons 2010.

28. Molina OF, dos Santos Jr J, Nelson SJ, Grossman E. Prevalence of modalities of headaches and bruxism among patients with craniomandibular disorder. *CRANIO®* 1997; **15** : 314-25.

29. Giannakopoulos NN, Hellmann D, Schmitter M et al. Neuromuscular interaction of jaw and neck muscles during jaw clenching. *J Orofac Pain* 2013; **27** : 61-71.

30. Messersmith L. An exploration of the changes in signs and symptoms associated with sleep bruxism that follow osteopathic manual therapy: a pilot study; 2015.

31. Knutson GA. Vectored upper cervical manipulation for chronic sleep bruxism, headache, and cervical spine pain in a child. *Journal of manipulative and physiological therapeutics* 2003; **26** : 395.

32. Keskinruzgar A, Kucuk AO, Yavuz GY et al. Comparison of kinesio taping and occlusal splint in the management of myofascial pain in patients with sleep bruxism. *Journal of back and musculoskeletal rehabilitation* 2019; **32** : 1-6.

33. Rathi M, Keniya N, Palekar TJ. Effect of Kinesio-Taping on pain and muscle activity in individuals with Bruxism.

34. Kafa N, Citaker S, Omeroglu S et al. Effects of kinesio logic taping on epidermal–dermal distance, pain, edema and inflammation after experimentally induced soft tissue trauma. *Physiotherapy theory and practice* 2015; **31** : 556-61.

Table 1: Comparison of Muscle Thickness and Stiffness Measurements Within Groups and Between Groups Before and After Treatment

		KTMT	KTMT	KTMT	KTMT	MT	MT	MT	MT
		Before Median IQR	After Median IQR	P within group	Change Median IQR	Before Median- IQR	After Median IQR	P within group	Change Median IQR
Muscle Thick- ness (cm)	Right	0.86 (0.70/0.98)	0.85 (0.70/0.97)	0.34		0.88 (0.78/0.94)	0.87 (0.75/0.95)	0.89	
	Left	0.81 (0.70/0.98)	0.72 (0.63/0.99)	0.50		0.82 (0.70/0.90)	0.74 (0.69/0.81)	0.44	
Muscle Stiffness (m/s)	Right	2.36 (2.12/2.54)	2.12 (1.88/2.36)	*0.006	0.18 (0.02/0.51)	2.48 (2.22/2.84)	2.06 (1.78/2.52)	*0.001	0.19 (0.04/0.57)
	Left	2.49 (2.31/2.66)	2.31 (1.90/2.44)	*0.001	0.29 (0.11/0.47)	2.53 (2.01/2.80)	1.98 (1.86/2.53)	*0.004	0.25 (0.02/0.54)

*p < 0.05 within the groups after four weeks' treatment (Wilcoxon Signed Ranks Test) and changes between groups (Mann-Whitney U Test), KTMT: Kinesio Taping plus Manual Therapy Group, MT: Manual Therapy Group, IQR: Interquartile Range, cm: Centimeter, m: Meter, s: second.

Table 2: Comparison of Pressure Pain Threshold Measurements Within Groups and Between Groups Before and After Treatment

		KTMT	KTMT	KTMT	KTMT	MT	MT	MT	MT
		Before Me- dian IQR (New- ton)	After Me- dian IQR (New- ton)	P within group	Change Me- dian IQR (New- ton)	Before Me- dian IQR (New- ton)	After Me- dian IQR (New- ton)	P within group	Change Me- dian IQR (New- ton)
Masseter	Right	30 (24/41)	39 (34/44)	*0.017	5.9 (- 1.9/14.9)	31 (25/35)	41 (35/45)	*0.001	8.8 (3.2/13.8)
	Left	32 (23/36)	44 (32/50)	*0.001	12.2 (8/15.4)	30 (24/36)	37 (28/46)	*0.034	6.7 (- 0.2/14.9)
Trapezius Occipital	Right	29 (24/39)	42 (33/46)	*0.023	10.1 (- 1.5/15.5)	27 (23/38)	34 (28/43)	0.088	4.8 (- 2.8/19.7)
	Left	35 (25/48)	42 (35/53)	*0.039	8.1 (-4/19.7)	28 (23/33)	33 (30/43)	*0.017	7.9 (- 0.6/16.7)
Trapezius Anterior	Right	38 (30/55)	58 (45/68)	*0.011	12.2 (1.9/27.9)	36 (27/41)	47 (38/48)	*0.001	7.2 (4.2/19.7)
	Left	40 (31/58)	41 (37/53)	0.059		35 (23/43)	36 (30/47)	0.35	
Trapezius Posterior	Right	53 (37/62)	61 (48/81)	0.20		42 (28/56)	45 (40/59)	0.41	
	Left	52 (36/69)	75 (55/96)	*0.002	14.4 (11/35.8)	46 (33/56)	56 (45/69)	*0.039	10.6 (0.4/24.5)
Temporalis	Right	39 (33/57)	53 (45/66)	*0.001		44 (32/54)	45 (39/66)	0.47	
	Left	45 (37/54)	53 (46/60)	*0.001		38 (30/47)	44 (38/55)	0.056	

*p < 0.05 within the groups after four weeks' treatment and changes between groups (Mann-Whitney U Test), KTMT: Kinesio Taping plus Manual Therapy Group, MT: Manual Therapy Group, IQR: Interquartile Range

Table 3: Comparison of Sleep Quality Measurements within Groups and Between Groups Before and After Treatment

		KTMT	KTMT	KTMT	KTMT	MT	MT	MT	MT
		Before Median IQR	After Median IQR	P within group	Change Median IQR	Before Median- IQR	After Median IQR	P within group	Change Median IQR

		KTMT	KTMT	KTMT	KTMT	MT	MT	MT	MT
Subjective sleep quality	Subjective sleep quality	1 (1/1)	1 (0.25/1)	0.21		1.5 (1/2)	1 (1/1)	*0.007	
Sleep latency	Sleep latency	1 (1/2)	1 (0/1)	*0.008	0 (0/1)	1 (1/3)	1 (1/1)	*0.008	0.5 (0/1)
Sleep duration	Sleep duration	0 (0/1)	1 (0/1.75)	0.68		0 (0/0.75)	1 (1/2)	*0.043	
Sleep efficiency	Sleep efficiency	0 (0/0)	0 (0/0)	1.00		0 (0/0)	0 (0/0)	0.32	
Sleep disturbance	Sleep disturbance	2 (1/2)	1 (1/1)	*0.004	1 (0/1)	2 (2/2)	1 (1/1)	*0.001	1 (0.25/1)
Use of sleep medication	Use of sleep medication	0 (0/0)	0 (0/0)	1.00		0 (0/0)	0 (0/0)	1.00	
Daytime dysfunction	Daytime dysfunction	1 (0.25/2)	0.5 (0/2)	0.053		2 (1/2.75)	2 (1/2)	0.31	
Global PSQI Score	Global PSQI Score	6 (4.3/7.8)	4 (3/5.75)	*0.019	2 (0.25/3)	8 (5/9)	6 (5.25/6)	*0.025	2 (0.75/4.25)

*p < 0.05 within the groups after four weeks' treatment (Wilcoxon Signed Ranks Test) and changes between groups (Mann-Whitney U Test), KTMT: Kinesio Taping plus Manual Therapy Group, MT: Manual Therapy Group, IQR: Interquartile Range, PSQI: The Pittsburgh Sleep Quality Index

Table 4: Comparison of Likert Measurements within Groups and Between Groups Before and After Treatment

		KTMT	KTMT	KTMT	KTMT	MT	MT	MT	MT
		Before Median IQR	After Median IQR	P within group	Change Median IQR	Before Median-IQR	After Median-IQR	P within group	Change Median IQR
Jaw Pain	Jaw Pain	3 (2/3)	1 (0/1.75)	*0.001	2 (1/2)	2 (1/3)	1 (0/1.75)	*0.001	1 (1/2)
Earache	Earache	1 (0.25/2)	0 (0/0)	*0.003	1 (0/2)	1 (0/2)	0 (0/0)	*0.011	0.5 (0/2)
Headache	Headache	2 (1/3)	0 (0/1)	*0.001	1.5 (1/2)	2 (0.25/3)	0.5 (0/1)	*0.003	1 (0/2)
Feeling Tense	Feeling Tense	2 (1/1.75)	1 (1/1)	*0.003	1 (0/2)	2 (2/2.75)	1 (1/1)	*0.008	1 (0/1)
Feeling Depressed	Feeling Depressed	1 (0/1)	0 (0/1)	*0.020	0 (0/1)	1 (1/2)	0 (0/1)	*0.007	1 (0.25/1)
Difficulties in Chewing	Difficulties in Chewing	1 (1/2)	0 (0/1)	*0.003	1 (0/2)	1 (0.25/2)	0 (0/0.75)	*0.002	1 (0/1)

* $p < 0.05$ within the groups after four weeks' treatment (Wilcoxon Signed Ranks Test) and changes between groups (Mann-Whitney U Test), KTMT: Kinesio Taping plus Manual Therapy Group, MT: Manual Therapy Group, IQR: Interquartile Range

All subscales were scored on a 5-point Likert (0-4) scale as; 0: none, 1: mild, 2: moderate, 3: severe, 4: very severe.

Appendix:

Acknowledgements

The authors have no conflicts of interest to disclose. Each of the authors has read and concurs with the content in the final manuscript. The material within has not been and will not be submitted for publication elsewhere. All authors contributed intellectually to the manuscript and the manuscript has been read and approved by all the authors.

Disclosure of Interest

The authors report no conflict of interest

Funding/Grant:

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.