European Annals of Dental Sciences
Official Publication of Ankara University, Faculty of Dentistry

EADS, 2025, 52 (3), 156–160

e-ISSN : 2757-6744
Article Received/Accepted : July, 6 2025 / September, 11 2025
doi : 10.52037/eads.2025.0022
Ethical Committee No : 12/2024-08

ORIGINAL RESEARCH ARTICLE

Assessment of Masseter Muscle Thickness Variations by Nationality in Female Bruxism Patients: An Ultrasonographic Study

Zarif Ece Hammudioğlu [1], *, Merve Küçük Kurtgöz [1], Elif Çeçen Erol [1] and Ceren Aktuna Belgin [1]

[1]Department of Dentomaxillofacial Radiology, Faculty of Dentistry, Hatay Mustafa Kemal University, Hatay, Türkiye

*Corresponding Author; zarifece92r@hotmail.com

Abstract

Purpose: This study aimed to compare the ultrasonographic (USG) characteristics of masseter muscle thickness and internal structure among female bruxism patients from two different nationalities.
Materials and Methods: A total of 60 female patients with bruxism (30 Turkish and 30 Syrian), aged between 18 and 25, were included in the study. Measurements were taken with USG on both sides of each patient, both at rest and at maximum contraction, based on the distances from the center of the distance between the zygomatic arch and the gonial angle, parallel to the occlusal plane, and from the center of the mediolateral distance of the ramus, perpendicular to the ramus. The internal structure of the masseter muscle was classified according to the visibility of echogenic bands. Gonial and antegonial angles were measured on panoramic radiographs (PR).
Results: A total of 60 female patients (mean age 22.2 ± 1.21 years) were evaluated. In the measurement of the masseter muscle at relaxation, it was determined that there was no statistically significant difference between the right and left (p=0.919) and between nationalities (p=0.465). In the measurement of the masseter muscle at clenching, it was determined that there was no statistically significant difference between the right and left (p=0.745) and between nationalities (p=0.235). When the distribution of the internal structure of the masseter muscle was compared on the right and left sides separately for both nationalities, no significant difference was found (p=0.215 and p=0.310, respectively). In the gonial angle measurement in PR, there was no statistically significant difference between the patients on the right and left sides (p=0.898) and between nationalities (p=0.101). In the antegonial angle measurement in radiographs, there was no statistically significant difference between the patients on the right and left sides (p=0.714) and between nationalities (p=0.235).
Conclusions: USG provides a radiation-free modality for evaluating changes in the masseter muscle. However, variations in masseter muscle thickness, internal structure, and mandibular angles between nationalities were not statistically significant.

Keywords: Bruxism; Masseter muscle; Nationality; Ultrasonography

Introduction

According to the World Health Organization, bruxism is defined as repetitive muscle activity consisting of unconscious, habitual teeth clenching and grinding and/or bracing or thrusting of the lower jaw. Bruxism is a parafunction that occurs as a craniomandibular dysfunction in 20% of adults. The symptoms of bruxism include pain during chewing, tooth wear, and muscle changes, such as hypertrophy, while the main symptom is stiffness of the masticatory muscles, which leads to limited mouth opening. [1] Previous studies have indicated that bruxism is not only a cause of attrition, tooth fractures, and prosthesis complications, but also a risk factor for various health conditions, including severe masticatory muscle pain and temporomandibular joint pain. [2] Various factors play a role in its etiology, including dental, skeletal, and occlusal disorders, as well as physical, biological, psychological, and pathological factors, including age and sex. Stress, anxiety, and depression are the psychological factors most frequently associated with the presence of bruxism. The incidence of bruxism is increasing, especially among young people; epidemiological studies indicate that it increased from 5% in 1966 to 25% in 2020, and stress levels have followed the same increasing trend. [3]

CC BY NC

How to cite: Hammudioglu ZE, Kucuk Kurtgoz M, Cecen Erol E, Aktuna Belgin C. Assessment of Masseter Muscle Thickness Variations by Nationality in Female Bruxism Patients: An Ultrasonographic Study. EADS. 2025;52(3): 156-160

OPEN ACCESS

The masseter muscle, a large and powerful chewing muscle within the muscles of mastication, can be considered the foundation of the stomatognathic system.[4] This muscle is directly affected by changes in occlusion and parafunctional habits, such as bruxism.[5] In the presence of bruxism, the masseter muscle has been shown to undergo adaptive transformations such as muscle hypertrophy, which is accepted as an indicator of jaw muscle activity.[6]

Various imaging procedures have been used to image the masticatory muscles, including computed tomography (CT), magnetic resonance imaging (MRI), and ultrasonography (USG). CT allows precise imaging of the skull, to which the masticatory muscles are attached. However, radiation and weak resolution of soft tissues make it inappropriate for measuring muscle thickness. MRI is currently considered the gold standard for demonstrating soft tissue pathologies, but its use is restricted due to its high price and contraindication in people who have metal implants. USG has several advantages over CT and MRI, including real-time assessment, no radiation, cost effectiveness, portability, ease of dynamic examination, and no known cumulative biological effects. In addition, USG can identify muscle fibers, which makes it highly effective in imaging muscle trauma and neuromuscular diseases.[7–9] With USG, it is possible to determine muscle thickness and obtain well-defined images of the masticatory muscle with high reproducibility, rapid imaging, and no exposure to ionizing radiation.[10] With panoramic radiography (PR), it is feasible to measure the gonial and antegonial angles, which can change shape and angle under the influence of the masticatory muscles. The gonial angle is the angle between the posterior limit of the mandibular ramus and the lower limit of the mandibular bone corpus. The antegonial angle is a notch in front of the gonion where the lower border of the mandible slopes upwards. This notch shows how the mandible will develop due to its location. Since the masseter muscle is located in the gonial angle region, its contraction force also affects the shape of the mandibular base.[11,12]

No previous study has compared USG images of masseter muscle thickness and internal structure in individuals of different nationalities. Therefore, this study aimed to comparatively evaluate the thickness and internal structure of the masseter muscle using USG and PR in female bruxism patients of different nationalities.

Material and Methods

Study design

The patient population included female patients aged 18–25 years who applied to the Oral, Dental, and Maxillofacial Radiology Clinic at Hatay Mustafa Kemal University's Faculty of Dentistry between January and December 2024 and whose first complaint during their examination was muscle pain due to bruxism. The following patients were excluded from the study: those with a medical history of trauma, surgical intervention, and/or developmental anomalies/pathologies in the maxillofacial region, especially in the temporomandibular joint; those with a systemic disease affecting growth and development; those with trigeminal neuralgia; those with any infection or inflammation in the masseter muscle; those receiving orthodontic treatment; and those with oral habits such as unilateral chewing. Routine intraoral and radiographic examinations were performed on patients who presented with a complaint of bruxism. Bruxism was diagnosed by anamnesis and clinical examination. The diagnosis was made using the following criteria:[13–15]

- The patient or his/her family or spouse reported the patient clenching and/or grinding their teeth at least three to five nights or days a week for at least six months.
- Abnormal wear of the teeth, hypertrophy of the masseter muscle, and pain on palpation of the muscle during clinical examination.
- Fatigue, pain, and discomfort in the jaw muscles, especially in the morning.

A total of 60 female patients who matched the study criteria were divided into two groups according to nationality: Turkish (30 women) and Syrian (30 women).

Ultrasonographic Assessment

An SIUI APOGEE 3300 (Shantou Institute of Ultrasonic Instruments Co. Ltd, China) USG device and a high-resolution, normal-sized, linear probe with a measurement accuracy of 0.01 cm at a frequency of 5–12 MHz were employed to evaluate the masseter muscle. System settings (image depth, gain, frame rate, and frequency) were kept at optimal levels throughout the study. Patients were seated upright with their heads in a natural position. A generous amount of gel was applied between the tissue and the probe to prevent tissue compression, and care was taken not to apply excessive pressure to the muscle. Measurements were taken on both sides of each patient, both at rest and at maximum contraction, based on the distances from the center of the distance between the zygomatic arch and the gonial angle, parallel to the occlusal plane, and from the center of the mediolateral distance of the ramus, perpendicular to the ramus.

The internal structure and distribution of the tendons of the masseter muscle at rest were then classified as Type 1, 2, or 3 according to the following classification developed by Ariji et al.[16]

- Type 1: The echogenic bands corresponding to the muscle tendons are clearly visible in the muscle.
- Type 2: The echogenic bands corresponding to the muscle tendons are thickened and appear to have decreased echogenicity.
- Type 3: The internal bands corresponding to the muscle tendons are reduced/absent.

Panoramic Radiographic Assessment

To ensure standardization, all panoramic radiographs were taken using the same device (Vatech Pax-i Co., Hwaseong, Korea), with the same exposure parameters (70 kVp, 10 mA, and 9.7 s exposure time), and by the same operator. The measurement of the gonial and antegonial angles of both sides were taken using the device's own software program, as follows:

- Gonial angle: A tangent line was drawn to the distal border of the ramus and the lower edge of the mandible. The angle between these two lines was measured.
- Antegonial angle: The angle formed by the intersection of the lines following the anterior and posterior slope of the antegonial notch.

After the first 20 measurements were performed under the supervision of a dentomaxillofacial radiologist (CAB with 10 years of clinical experience), the measurements were continued by three other previously calibrated observers (ZEH with three years of clinical experience; MKK with at least one year of clinical experience; ECE with at least three years of clinical experience). All measurements were made twice by each of the three observers.

Statistical Analysis

SPSS version 29 (SPSS Inc., Chicago, IL, USA) was employed to perform the statistical analysis. Descriptive statistics of the measurements were calculated as mean, standard deviation (SD), number, and % frequencies. The Shapiro–Wilk test was used to determine if the data were normally distributed, and it was found that all measurements showed normal distribution. The variability of the difference between the left and right sides of the patients in both groups was determined using two-way repeated measures ANOVA, while the relationship between internal structure and ethnicity was

Table 1. Descriptive values of metric measurements by nationality and right/left side

Variable	Side	Turkish(n=30) Mean±SD	Turkish Median (25-75)	Syrian(n=30) Mean±SD	Syrian Median (25-75)	P+
Relaxing(mm)	Right	0.993±0.237	0.985(0.837-1.130)	0.979±0.249	0.985(0.813-1.155)	0.919
	Left	1.004±0.216	0.980(0.798-1.133)	1.006±0.252	0.950(0.825-1.273)	0.762±
Clenching(mm)	Right	1.450±0.279	1.460(1.328-1.595)	1.418±0.334	1.440(1.258-1.593)	0.745
	Left	1.407±0.261	1.440(1.230-1.538)	1.392±0.295	1.315(1.180-1.685)	0.763±
Gonial angle(°)	Right	123.18±8.47	121.26(117.80-126.13)	122.31±7.73	122.45(118.79-126.85)	0.898
	Left	123.59±7.78	121.90(118.78-127.41)	123.95±7.63	123.78(119.74-128.56)	0.321±
Antegonial angle(°)	Right	165.75±6.69	166.80(160.75-170.39)	165.71±8.43	167.77(159.94-172.36)	0.714
	Left	166.02±6.88	167.34(159.61-171.52)	167.30±6.47	168.24(162.93-173.10)	0.401±

+: P-value for nationality comparison (Turkish vs Syrian). ±: P-value for right-left side comparison within groups.

Table 2. Internal distribution of the masseter muscle

	Right				Left			
	Turkish		Syrian		Turkish		Syrian	
	n	%	n	%	n	%	n	%
Type 1	8	26.7	3	10.0	4	13.3	4	13.3
Type 2	17	56.7	19	63.3	21	70.0	16	53.3
Type 3	5	16.7	8	26.7	5	16.7	10	33.3
P*	0.215				0.310			

*: P-values for comparing nationalities on the left and right sides. $p < 0.05$ considered statistically significant.

evaluated using the Pearson chi-squared test, and the distinction between left and right internal structures in both groups was evaluated separately using the Wilcoxon sign rank test. The Cohen's kappa test was used for accuracy analysis. $P < 0.05$ was accepted as the level of statistical significance.

Results

A total of 60 female patients (30 Turkish and 30 Syrian) with bruxism, aged 18–25 years (mean 22.2 ± 1.21 years), were evaluated using both USG and PR. The inter-observer agreement (k = 0.881) and intra-observer agreement (k = 0.840) were calculated, both indicating favorable agreement.

Ultrasonographic Assessment

Descriptive values of numerical measurements according to nationality and right–left side are presented in Table 1. In the Turkish patients, the mean right masseter muscle thickness was 9.93 ± 2.37 mm while at rest and 14.50 ± 2.79 mm while clenching, and on the left side, it was 10.04 ± 2.16 mm and 14.07 ± 2.61 mm, respectively. In the Syrian patients, the average right masseter muscle thickness was recorded as 9.79 ± 2.49 while at rest and 14.18 ± 3.34 mm while clenching, and on the left side, it was 10.06 ± 2.52 mm and 13.92 ± 2.95 mm, respectively. The measurement of the masseter muscle while at rest showed no statistically significant difference between the right and left sides ($p = 0.919$) or between the two nationalities ($p = 0.465$) (Table 1). The measurement of the masseter muscle at maximum contraction (while clenching) showed no statistically significant difference between the right and left sides ($p = 0.745$) or between the two nationalities ($p = 0.235$) (Table 1). The internal structure distribution of the masseter muscle on the right and left sides of both groups is provided in Table 2. When the distribution of the internal structure of the masseter muscle on the right and left sides was compared separately for both nationalities, no significant differences were found ($p = 0.215$ and $p = 0.310$, respectively).

Panoramic Radiographic Assessment

In the gonial angle measurement in PR, no statistically significant difference was found between the right and left sides ($p = 0.898$) or between the two nationalities ($p = 0.101$). In the antegonial angle measurement in PR, no statistically significant difference was found between the right and left sides ($p = 0.714$) or between the two nationalities ($p = 0.235$).

Discussion

Bruxism is a movement disorder that affects the masticatory system, characterized by involuntary clenching and grinding of the teeth during sleep (sleep bruxism) or wakefulness (awake bruxism). The masseter muscle, an important muscle in chewing, is frequently affected by bruxism. Psychological stress and long-term low-level contraction due to long-term overactivity of the muscle can cause an edematous alteration in the muscle, resulting in a change in the internal echogenic pattern of the muscle and muscle hypertrophy.[17] It is known that bruxism, which is a common phenomenon between the ages of 15 and 40, is affected by factors such as age and sex.[18] Based on these data, patients between the ages of 15 and 25, in whom bruxism is frequently seen, were included in the current study, and only female patients were selected to rule out sex-related differences. Besides stress, other factors affecting bruxism are known to be differences in sociocultural status, environmental, and economic factors. Environmental factors include geography, regional warfare and migration constraints, nationality, and cultural and genetic heritage. It is believed that the prevalence of bruxism will also be higher in regions with high stress levels due to the influence of these factors.[19] Therefore, this study investigated whether there are international differences in the masseter muscle in patients with bruxism.

USG is a safe and noninvasive imaging method that can visualize soft tissue structures, especially superficial structures in the head and neck region, in detail. It is widely used in the evaluation of the masseter muscle, and the internal structure of the muscle can be visualized more clearly with USG than with CT or MRI.[17,18,20] Because of these advantages, USG was the preferred imaging tool in our study.

Many previous studies have evaluated the thickness of the masseter muscle in young adults with bruxism;[13,21] however, only one previous study explored this variation according to nationality.[3] In their study, Fluerașu et al.[3] found no relationship between age, sex, and nationality and bruxism. Although our study used different materials and methods, our findings were similar, as we observed that the thickness of the masseter muscle in patients with bruxism did not vary according to nationality. Aslan et al.[13] measured the thickness of the masseter muscle in patients with bruxism and found that the maximum thickness on the right side was 11.32 ± 2.32 mm while at rest and 13.52 ± 2.32 mm while clenching, while on the left side it was 9.95 ± 1.78 mm and 12.57 ± 2.29 mm, respectively. In their study on 40 Iraqi patients with bruxism, Najm et

al.[21] found that the mean masseter muscle thickness was 11.7 ± 1.4 mm at rest and 16.4 ± 1.3 mm while clenching. When the masseter muscle in bruxism patients is examined with USG, the increase in muscle thickness is remarkable.[13,21] Although the exact cause of this thickening has not been identified, it may be that the increase in the diameter of the muscle fibers when the muscle contracts causes thickening or that the edematous modification in the muscle causes this increase.[16] In this study, the mean masseter muscle thickness in Turkish patients with bruxism was 9.93 ± 2.37 mm while at rest and 14.50 ± 2.79 mm while clenching, and in Syrian patients, it was 9.79 ± 2.49 and 14.18 ± 3.34 mm, respectively. Although previous studies were based on different methodologies and designs and consisted of different populations and patient numbers, the morphometric measurements found in our study are consistent with the literature.

In the USG image of an inflammatory muscle that causes myofascial pain, such as in bruxism, echogenic bands corresponding to the inner fascia or tendon of the muscle are often reduced or may disappear. It is also known that edematous muscle shows less echogenicity than non-edematous muscle.[17] Infiltration of water content caused by edematous change homogenizes the impedance of the two tissues, and the reflected sound is weakened, resulting in less echogenicity.[16] In the light of this information, when the internal structure of the masseter muscle in bruxism patients is examined, Ariji et al.[16] reported that the most common internal structure type in these patients was Type 2 (64%), followed by Type 3 (20%) and Type 1 (16%). Our study indicated that Type 2 internal structure was the most common type in Turkish patients, followed by Type 1 and Type 3, while in Syrian patients, Type 2 internal structure was the most common, followed by Type 3 and Type 1. However, no significant correlation between nationality and internal changes in the masseter muscle structure was observed.

The mandible is not a weight-bearing bone, and the gravitational force acting on the mandible is very low; thus, the daily freight on the mandible is caused by muscle contractions and the resulting reaction forces. Many muscle groups are attached to the mandible, and the most important load-bearing ones are thought to be the masticatory muscles.[22] Measurable differences in the dimensions of the mandibular bone may occur due to the impact of the masticatory muscles. Changes in the gonial and antegonial angles in patients with bruxism have been examined in the literature, but no previous study has investigated the correlation between these changes and ethnic origin. For this reason, it is thought that our study will contribute to the literature. Karslıoğlu et al.[23] evaluated craniomorphological changes in patients with bruxism. They found that the average gonial angle was 120.77°, while the average antegonial angle was 166.60. Unal Erzurumlu et al.[24] investigated the effect of bruxism on antegonial angle depth, gonial angle depth, and antegonial index and found that antegonial angle depth increased in bruxism patients. However, they stated that a limitation of their study was that they did not include the duration of their patients' bruxism in their statistical analysis. In our study, we included patients who had complained about the symptoms of bruxism for at least six months. In addition, we investigated whether the gonial and antegonial angles in bruxism patients differed according to ethnicity, contributing to the knowledge that while the antegonial angle changed with bruxism, no significant difference between different nationalities was found.

One of the limitations of this study was that we did not use polysomnography to diagnose bruxism. Patients were diagnosed with bruxism based on patient history and clinical findings. This may lead to problems such as patients misleading the clinician and misinterpreting clinical findings, which may lead to the clinician making an incorrect diagnosis. Another limitation is that patients with bruxism were not separated into sleep- and awake-type bruxism. These limitations should be addressed in future studies.

Conclusion

In conclusion, ultrasonography provides a radiation-free modality for evaluating changes in the masseter muscle. Our study found that variations in masseter muscle thickness, internal structure, and mandibular angles in patients of two different nationalities were not statistically significant.

Ethical Approval

This study was approved by the Local Ethics Committee of the Hatay Mustafa Kemal University (Date:18.12.2024, Decision no:08). The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Acknowledgements

None.

Financial Support

No funding was received for this study.

Author Contributions

Study planning : All Authors
Data collection and analysis : Z.E.H. , M.K.K. , E.C.E.
Interpretation, manuscript writing : Z.E.H. , M.K.K. , E.C.E.
Critical reviewing : C.A.B.
Contributed to the final version : All Authors

Conflict of Interest

The authors declare that there is no conflict of interest.

Authors' ORCID(s)

Z.E.H. 0000-0003-1271-9234
M.K.K. 0009-0009-2161-7134
E.C.E. 0009-0003-1624-3963
C.A.B. 0000-0001-7780-3395

References

1. Takeuchi T, Arima T, Ernberg M, Yamaguchi T, Ohata N, Svensson P. Symptoms and physiological responses to prolonged, repeated, low-level tooth clenching in humans. Headache. 2015;55(3):381–394. doi:10.1111/head.12528.
2. Manfredini D, Poggio CE, Lobbezoo F. Is bruxism a risk factor for dental implants? A systematic review of the literature. Clin Implant Dent Relat Res. 2014;16(3):460–469. doi:10.1111/cid.12015.
3. Fluerașu MI, Bocșan IC, Țig IA, Iacob SM, Popa D, Buduru S. The Epidemiology of Bruxism in Relation to Psychological Factors. Int J Environ Res Public Health. 2022;19(2). doi:10.3390/ijerph19020691.
4. Oliveira JHPd, Dourado Filho MG, Lima NS, Silva HJd, Marcelino Filho M. Relationship of the thickness and electric activity of the masseter muscle with bite force: a morphological and electrophysiological study. Revista Cefac. 2016;18:589–600.

5. Ispir NG, Toraman M. The relationship of masseter muscle thickness with face morphology and parafunctional habits: an ultrasound study. Dentomaxillofac Radiol. 2022;51(8):20220166. doi:10.1259/dmfr.20220166.
6. Orhan K, Yazici G, Önder M, Evli C, Volkan-Yazici M, Kolsuz ME, et al. Development and Validation of an Ultrasonography-Based Machine Learning Model for Predicting Outcomes of Bruxism Treatments. Diagnostics (Basel). 2024;14(11). doi:10.3390/diagnostics14111158.
7. Talmaceanu D, Lenghel LM, Bolog N, Hedesiu M, Buduru S, Rotar H, et al. Imaging modalities for temporomandibular joint disorders: an update. Clujul Med. 2018;91(3):280–287. doi:10.15386/cjmed-970.
8. Van Den Engel-Hoek L, Lagarde M, Van Alfen N. Ultrasound of oral and masticatory muscles: Why every neuromuscular swallow team should have an ultrasound machine. Clin Anat. 2017;30(2):183–193. doi:10.1002/ca.22818.
9. Wu WT, Chang KV, Mezian K, Naňka O, Lin CP, Özçakar L. Basis of Shoulder Nerve Entrapment Syndrome: An Ultrasonographic Study Exploring Factors Influencing Cross-Sectional Area of the Suprascapular Nerve. Front Neurol. 2018;9:902. doi:10.3389/fneur.2018.00902.
10. Reis Durão AP, Morosolli A, Brown J, Jacobs R. Masseter muscle measurement performed by ultrasound: a systematic review. Dentomaxillofac Radiol. 2017;46(6):20170052. doi:10.1259/dmfr.20170052.
11. Joo JK, Lim YJ, Kwon HB, Ahn SJ. Panoramic radiographic evaluation of the mandibular morphological changes in elderly dentate and edentulous subjects. Acta Odontol Scand. 2013;71(2):357–362. doi:10.3109/00016357.2012.690446.
12. Okşayan R, Asarkaya B, Palta N, Şimşek I, Sökücü O, İşman E. Effects of edentulism on mandibular morphology: evaluation of panoramic radiographs. ScientificWorldJournal. 2014;2014:254932. doi:10.1155/2014/254932.
13. Aslan EM, Artaş A. Ultrasonographic Assessment of Masseter and Anterior Temporal Muscle Thickness and Internal Structure in Young Adult Patients With Bruxism. J Clin Ultrasound. 2025;53(2):286–293. doi:10.1002/jcu.23866.
14. Lobbezoo F, Ahlberg J, Raphael KG, Wetselaar P, Glaros AG, Kato T, et al. International consensus on the assessment of bruxism: Report of a work in progress. J Oral Rehabil. 2018;45(11):837–844. doi:10.1111/joor.12663.
15. Murali RV, Rangarajan P, Mounissamy A. Bruxism: Conceptual discussion and review. J Pharm Bioallied Sci. 2015;7(Suppl 1):S265–70. doi:10.4103/0975-7406.155948.
16. Ariji Y, Sakuma S, Izumi M, Sasaki J, Kurita K, Ogi N, et al. Ultrasonographic features of the masseter muscle in female patients with temporomandibular disorder associated with myofascial pain. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2004;98(3):337–341. doi:10.1016/j.tripleo.2004.06.068.
17. Ariji E, Ariji Y, Yoshiura K, Kimura S, Horinouchi Y, Kanda S. Ultrasonographic evaluation of inflammatory changes in the masseter muscle. Oral Surg Oral Med Oral Pathol. 1994;78(6):797–801. doi:10.1016/0030-4220(94)90098-1.
18. Palinkas M, Bataglion C, de Luca Canto G, Machado Camolezi N, Theodoro GT, Siéssere S, et al. Impact of sleep bruxism on masseter and temporalis muscles and bite force. Cranio. 2016;34(5):309–315. doi:10.1080/08869634.2015.1106811.
19. Alharby A, Alzayer H, Almahlawi A, Alrashidi Y, Azhar S, Sheikho M, et al. Parafunctional Behaviors and Its Effect on Dental Bridges. J Clin Med Res. 2018;10(2):73–76. doi:10.14740/jocmr3304w.
20. Raghunandan Iyengar A, Patil S, Guddannanavar Karibasappa G, Beloor Vasudev S, Kumar Joshi R. Evaluation of Internal Echogenic Pattern of Masseter in Subjects with Myofascial Pain/ Myositis, Oral Submucous Fibrosis, Chewers, Bruxers and Healthy Individuals- A Preliminary Ultrasonographic Study. J Dent (Shiraz). 2016;17(4):361–366.
21. Najm AA. Sonographic evaluation of masseter muscle thickness in bruxist and non-bruxist subjects. Journal of Baghdad College of Dentistry. 2014;26(3):49–52.
22. de Jong WC, Korfage JA, Langenbach GE. The role of masticatory muscles in the continuous loading of the mandible. J Anat. 2011;218(6):625–636. doi:10.1111/j.1469-7580.2011.01375.x.
23. KARSLIOĞLU H, Çitir M, Uzun C. Bruksizmin Antegonial ve Gonial Bölgedeki Etkilerinin Değerlendirilmesi: Analitik Araştırma. Turkiye Klinikleri Journal of Dental Sciences. 2024;30(4). doi:10.5336/dentalsci.2024-104152.
24. Unal Erzurumlu Z, Sadik E, Gokkurt BN, Ozbey F, Erzurumlu K, Kasko Arici Y. Morphological evaluation of gonial and antegonial regions in bruxers on panoramic radiographic images. BMC Oral Health. 2023;23(1):457. doi:10.1186/s12903-023-03162-0.