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Is There A Relationship Between Chewing Side Preference and Brain Laterality in Bruxers and Non-Bruxers?

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Abstract

Objective: There is no consensus on the etiology of unilateral mastication. While some studies argue that environmental factors such as missing teeth, teeth with restoration, pain, dental caries and temporomandibular disorder affect chewing side preference, others claim that brain laterality associated with hand, foot, ear and eye preferences also influences a chewing side preference. The aim of this study was to evaluate the relationship between the direction of unilateral chewing preference and brain laterality in fully dentate bruxers and non-bruxers (fully dentate or with missing and/or restored teeth).

Methods: Brain laterality of the subjects (n=132) was determined based on responses to questions about extremity and sensory preferences. The reliable visual analogue scale (VAS), Kazazoglu's method and the sunflower seed shell cracking test were used to determine chewing side preference (CSP).

Results: CSP as determined by VAS was not associated with brain laterality. While extremity and sensory preferences were predominantly right-sided (dominant left hemisphere) in all groups, the frequency of the left-side chewing was found to be high only among bruxers (p>0.05). No significant association was found between the results of VAS and other techniques (p>0.05).

Conclusion: The left-side CSP is observed more commonly in bruxers, suggesting that different central and peripheral mechanisms may be involved in bruxers.

Keywords: Chewing side preference; Laterality; Bruxism.

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INTRODUCTION

Cerebral lateralization is described as the anatomical and functional differentiation between the left and right hemispheres of the brain (1). It also means that a hemisphere is predominantly responsible for control of a specific function (2). Functional cerebral lateralization refers to hand, foot, ear, and eye preferences (3).

Although chewing, the first step of digestion process (4), can occur bilaterally, it is considered that most people chew more on a particular side (right or left), that is, there is a chewing side preference (CSP) (5, 6).

There is no consensus on the etiology of unilateral mastication (7). While some studies argue that environmental factors such as missing teeth, teeth with restoration, pain, dental caries and temporomandibular disorder (TMD) affect chewing side preference (6-9), others claim that brain laterality associated with hand, foot, ear and eye preferences also influences CSP (3, 10, 11).

Clinically, lateralization is determined based on upper extremity tests (mostly hand) as well as information collected through eye (e.g., dominant eye test, eye deviation test), ear and lower extremity tests (foot) (12).

Bruxism is defined as parafunctional grinding and clenching of the teeth caused by nocturnal and/or diurnal activity of the masticatory muscles. Due to the controversial nature of this habit, most investigators state that the etiology of bruxism is multifactorial. Several methods and techniques are employed for the assessment of bruxism, including questionnaires, clinical examination, intraoral appliances, electromyography (EMG) and polysomnography (sleep laboratory) recordings. According to the clinical diagnosis, bruxism is graded as follows: possible, probable and definite bruxism. According to this system, “possible” bruxism is based on self-reporting through questionnaires and/or the anamnestic part of the clinical examination. The method involving self-report questionnaires in combination with clinical assessment of bruxism is commonly used in large-scale studies due to its convenience, and allows for making a diagnosis of “probable” bruxism (13, 14). “Definite” bruxism is diagnosed on the basis of self- reporting, a clinical examination, and polysomnographic or electromyographic recordings of the patients (13).

In a 2006 study, Fujita et al. (15) reported that bruxism is the most common behavior in patients with TMD and found a significant association between bruxism and unilateral chewing. Similarly, Yeler et al. (16) also reported a significant relationship between bruxism and unilateral chewing. However, the relationship between the direction of unilateral chewing preference observed in bruxists and brain laterality has not been evaluated to date.

Although various methods are available to determine CSP (8, 17), there is still a lack of a widely accepted "gold standard" method for this purpose (17). Moreover, it has been noted that the nature of the test materials used in studies affects the assessment of the chewing side preference (18, 19). While Kazazoglu's method (20) uses a non-dissolving chewing gum with high cohesiveness and strong adhesiveness as test material, hard and solid foods such as almonds and roasted chickpeas are used in the VAS (visual analogue scale) method. In previous studies, VAS has been reported as the most reliable method to determine CSP (17).

Considering that a number of factors may negatively affect the test results, including the inability of the clinician to directly and simultaneously observe CSP, possible effects of the test environment on the patient and the period of thinking involved in the testing process, the authors of this study sought to determine whether "a simple gesture of cracking sunflower seed shells with the teeth can be used as a method to determine CSP".

The aims of this study were threefold: 1) to investigate the relationship between brain laterality and unilateral chewing preference as determined by VAS and Kazazoglu's method in fully dentate bruxers, fully dentate non-bruxers and non-bruxers with missing and/or restored teeth, 2) to evaluate the direction of unilateral chewing preference observed in all groups, and 3) to investigate whether cracking sunflower seed shells with the teeth can be reliably used to determine chewing side preference as an alternative to the established VAS method.

METHODS

Patient selection

The study protocol was approved by the Ethics Committee on Non-Interventional Clinical Trials of Sivas Cumhuriyet University on 14.04.2021 (No. 2021–04/06). The study was conducted in accordance with the principles laid out in the Declaration of Helsinki.

This study was conducted from April to December 2021 with 132 individuals (16 to 30 years of age) who presented to the Oral and Maxillofacial Radiology clinic of Sivas Cumhuriyet University Faculty of Dentistry for routine dental examination. Written informed consent was obtained from all individuals before initiation of the study.

G*Power version 3.1.9.4 was used for sample size calculation and power analysis, which showed that a total of 44 subjects (22 females, 22 males) would be needed for the study at $\alpha = 0.05$, $\beta = 0.20$, $1\text{-}\beta = 0.80$ and $d = 0.41$, with a test power of $p=0.806$. Individuals who presented to the clinic and met the inclusion criteria defined for each group were randomly included in the study. Three groups were constructed for the study: fully dentate bruxers (Group I), fully dentate non-bruxers (Group II) and non-bruxers with missing or restored teeth (Group III). These groups were compared in terms chewing side preference and brain laterality.

The Karaduman Chewing Performance Scale (KCPS) was used to evaluate whether the groups have normal chewing function. KCPS classifies chewing function on a scale from 0 to 4. For normal chewing function, an individual must be able hold and bite on solid food, break down the food between the molars into small pieces and then swallow. Normal chewing function is assigned a score of 0 (21). In the current study, subjects with a score of 0 were included in each study group.

All study groups consisted of patients with normal chewing function and periodontal status, Angle Class I malocclusion, and no complaints of temporomandibular joint pain and/or orofacial pain. Dentate bruxers with no missing teeth other than third molars and self-reported teeth clenching/grinding for at least 6 months were included in Group I, and dentate non-bruxers with no missing teeth other than third molars without complaints of bruxism were assigned to Group II. Non-bruxers with missing and/or restored teeth were included in Group III, provided that the missing teeth or restorations were in the ipsilateral half jaws. Individuals with a bilateral chewing habit, a history of dental pain or masticatory muscle pain, ongoing orthodontic treatment and periodontal disease were excluded from the study.

In this study, the questionnaire proposed by Pintado et al. (22) and the clinical selection criteria described by Rompré et al. (23) were used for the diagnosis of probable bruxism. Responses to the questionnaire, clinical findings, and the diagnosis of bruxism were evaluated by a single dentomaxillofacial radiologist with 3 years of experience.

Using Pintado et al.'s criteria, bruxers were identified based on a positive answer to at least 2 of the following questions (22):

1. Has anyone ever told you that you grind your teeth at night?
2. Have you ever felt jaw fatigue on awakening in the morning?
3. Do you feel pain in your teeth and gums when you wake up in the morning?
4. Have you ever had headache on awakening in the morning?
5. Have you ever noticed that you grind your teeth during the day?
6. Have you ever noticed that you clench your teeth during the day?

Additionally, a diagnosis of bruxism was made when a subject met all of the clinical diagnostic criteria for bruxism proposed by Rompré et al. (23):

1. Self-reported teeth grinding at least 3 nights a week in the last 6 months,
2. The presence of clinical symptoms of tooth wear consistent with normal or eccentric jaw movements.
3. The presence of hypertrophy in the masseter muscle during voluntary contraction.
4. Self-reported fatigue, tenderness or stiffness in the chewing muscles after waking up in the morning.

Brain Laterality Test

Survey questions proposed by Nissan et al. (10) were used to determine brain laterality. For this test, all subjects responded to questions on 3 different tasks specific for handedness, footedness, eyedness and earedness, and individual preferences on a total of 12 tasks were noted.

Brain Laterality Test:

HAND:

-Hand used for throwing a ball

- Hand used for making a drawing

- Had used for erasing

FOOT:

-Foot used for kicking a ball

- Foot used to stomp on an object

- Foot used for standing on one leg

EAR:

-Ear used for listening through a hole

- Ear used for listening to a telephone

- Ear used for a single wired earpiece

EYE:

- Eye used for looking through a keyhole

- Eye used for looking through a dark hole

- Eye used for looking through a camera viewfinder

Based on patients' answers to the survey questions, the preferred side was recorded as right side, left side or both sides. Additionally, an I index was computed for each organ using the formula I = (R - L) / (R + L), where R is the number of tasks performed using the right side and L is the number of tasks performed using the left side,

The subject was considered right handed if I= +1 or left-side dominant if I= -1. A tendency for the right side was considered if I < 1. Left side dominance was considered if I > -1 or I= -1. If I = 0, the subject was considered as ambidextrous (10, 11).

Methods Used for Determining Preferred Chewing Side

Visual Analogue Scale (VAS)

The Visual Analogue Scale (VAS) is an easy and quick method that effectively assesses the degree of masticatory laterality. The scale is coded as (-1) for always using the left side, (+1) for always using the right side and (0) for using both sides equally. The subjects are asked to mark the preferred side for mastication on the scale after chewing hard foods such as almonds and roasted chickpeas (18).

Kazazoglu Method

The Kazazoglu method was used as an additional method to determine CSP of the groups. In this study, the data obtained using the

Kazazoglu method and VAS technique were compared.

This method was developed by Kazazoglu and consists of two parts, namely Observed Preferred Chewing Side and State Preferred Chewing Side. In the “Observed Preferred Chewing Side” part of the test, the chewing side is determined by visual inspection of the position of a chewing gum in the mouth after 1, 3, 5 and 7 consecutive chewing cycles. If three bites are observed on the same side of the chewing gum, then that side is considered as the chewing side. The “State Preferred Chewing Side” is determined based on the side where the chewing gum is located in the mouth after 2 minutes of chewing (18).

Sunflower Seed Shell Cracking (SSSC) Test

The Sunflower Seed Shell Cracking test was used in the current study based on the premise that it could be used to determine chewing side preference. For this test, the subject was asked to crack a shelled sunflower seed and the side that was first used for cracking was considered as the preferred chewing side. CSP was marked as right, left and the middle of the teeth and the agreement between the results of SCCC and VAS methods was investigated.

Statistical Analysis

The study data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 22.0 (IBM Corp., Armonk, NY). The study employed a single-blind method. Chi-square test and Fisher’s exact test were used as appropriate for evaluating categorical variables and descriptive statistics. Categorical variables were reported as counts and percentages (%). Cohen's Kappa test was employed to investigate intra-observer reliability. The tests and methods used to determine chewing side preference were repeated at 1-week intervals by a single observer on 33 (25%) randomly selected patients to calculate intra-observer repeatability. Kappa (κ) coefficients were interpreted as follows: < 0.0, no agreement; 0.0 to 0.20, slight agreement; 0.21 to 0.40, fair agreement; 0.41 to 0.60, moderate agreement; 0.61 to 0.80, substantial agreement; 0.81 to 1.00, perfect agreement (24). P values less than 0.05 were considered statistically significant.

RESULTS

In this study, 196 individuals were evaluated, and 132 of them who met the study criteria

were included. The mean age of the study sample was 21.27 ± 2.97 years. The mean age was 21.65 ± 2.54 years in fully dentate bruxers, 21.15 ± 3.36 years in fully dentate non-bruxers and 21 ± 2.98 years in non-bruxers with missing and/or restored teeth. There was no significant age difference among the groups (p>0.05).

Regarding intra-observer agreement, while the VAS method showed substantial agreement (0.74) and the SSSC test exhibited perfect agreement (0.93), fair agreement (0.27) was found for the observed preferred chewing side of Kazazoglu's test. The state preferred chewing side of Kazazoglu test was found to be non-reliable (0.5).

In the group of fully dentate bruxers, no significant association was found between CSP as determined by the VAS method and hand, foot, eye and ear preferences (p>0.05). In this group, extremity and sensory preferences were predominantly on the right side, whereas their chewing side preferences showed left side dominance (Table 1).

There was no significant association between VAS-assessed CSP and hand, foot, eye and ear preferences in fully dentate non-bruxers (p>0.05). In this group, CSPs were in the same direction and predominantly right-sided, which were at lower rates when compared with extremity and sensory preferences (Table 2).

No significant association was observed between VAS-assessed CSPs and hand, foot, eye and ear preferences among non-bruxers with missing and/or restored teeth (p>0.05). CSPs also showed right side dominance in this group, which was at a lower rate than extremity and sensory preferences (Table 3).

Table 1. Relationship between CSP and hand, foot, ear and eye preferences in fully dentate bruxers

		CSP as assessed by VAS			
		Right n (%)	**Left n (%)**	**Total n (%)**	**p**
HAND	**Right**	17 (44.7)	21 (55.3)	38 (86.4)	0.684
	Left	2 (33.3)	4 (66.7)	6 (13.6)	
FOOT	**Right**	17 (50)	17 (50)	34 (77.8)	0.148
	Left	2 (20)	8 (80)	10 (22.2)	
EAR	**Right**	15 (41.7)	21 (58.3)	36 (81.8)	0.710
	Left	4 (50)	4 (50)	8 (18.2)	
EYE	**Right**	17 (51.5)	16 (48.5)	33(75)	0.081
	Left	2 (18.2)	9 (81.8)	11 (25)	
CSP	**Total**	19 (43.2)	25 (56.8)	44 (100)	

CSP: Chewing Side Preference, VAS. Visual Analogue Scale
*Chi-square test (p denotes significance level, *p<0.05: statistically significant.)*

Table 2. Relationship between CSP and hand, foot, ear and eye preferences in fully dentate non- bruxers

		CSP as assessed by VAS			
		Right n (%)	**Left n (%)**	**Total n (%)**	**p**
HAND	**Right**	29 (67.4)	14 (32.6)	43 (93.3)	0.341
	Left	1 (100)	0 (0)	1 (6.7)	
FOOT	**Right**	14 (35.9)	25 (64.1)	39 (88.6)	0.647
	Left	4 (80)	1 (20)	5 (11.4)	
EAR	**Right**	24 (64.9)	13 (35.1)	37 (84.1)	1.000
	Left	5 (71.4)	2 (28.6)	7 (15.9)	
EYE	**Right**	24 (70.6)	10 (29.4)	34 (77.3)	0.271
	Left	5 (50)	5 (50%)	10 (22.7)	
CSP	**Total**	25 (65.9)	19 (34.1)	44 (100)	

CSP: Chewing Side Preference, VAS- Visual Analogue Scale
**p<0.05: statistically significant.*

Table 3. Relationship between CSP and hand, foot, ear and eye preferences in the non-bruxers with missing and/or restored teeth

		CSP as assessed by VAS			
		Right n (%)	**Left n (%)**	**Total n (%)**	**p**
HAND	**Right**	26 (63.4)	15 (36.6)	41 (93.2)	0.062
	Left	0 (0)	3 (100)	3 (6.8)	
FOOT	**Right**	24 (63.2)	14 (36.8)	38 (86.4)	0.208
	Left	2 (33.3)	4 (66.7)	6 (13.6)	
EAR	**Right**	21 (56.8)	16 (43.2)	37 (84.1)	0.682
	Left	5 (71.4)	2 (28.6)	7 (15.9)	
EYE	**Right**	23 (65.7)	12 (34.3)	35 (79.5)	0.128
	Left	3 (33.3)	6 (66.7)	9 (20.5)	
CSP	**Total**	26 (59.1)	18 (40.9)	44 (100)	

CSP: Chewing Side Preference, VAS: Visual Analogue Scale

**p<0.05: statistically significant.*

Table 4. Relationship between VAS and Kazazoglu method in the study groups

			Kazazoğlu (Observed)				
	Groups		**Right n (%)**	**Left n (%)**	**Both n (%)**	**Total n (%)**	**p**
VAS	**Fully dentate bruxers**	Right	11 (44)	5 (45.5)	3 (37.5)	19 (43.2)	0.935
		Left	14 (56)	6 (54.5)	5 (62.5)	25 (56.8)	
		Total	25 (56.8)	11 (25)	8 (18.2)	44 (100)	
	Fully dentate non-bruxers	Right	14 (63.6)	8 (80)	7 (58.3)	29 (65.9)	0.538
		Left	8 (36.4)	2 (20)	5 (41.7)	15 (34.1)	
		Total	22 (50)	10 (22.7)	12 (27.3)	44 (100)	
	Non-bruxers with missing and/or restored teeth	Right	18 (72)	6 (46.2)	2 (33.3)	26 (59.1)	0.118
		Left	7 (28)	7 (53. 8)	4 (66.7)	18 (40.9)	
		Total	25 (56.8)	13 (29.5)	6 (13.6)	44 (100)	

VAS: Visual Analogue Scale

*Chi-square test (p denotes significance level, *p<0.05: statistically significant.)*

In the current study, Kazazoglu's observed preferred chewing side method was used to determine CSP and compared with the VAS method, since the intra-observer agreement was lower for Kazazoglu's state preferred chewing side method. As a result, no significant association was found between the VAS method and Kazazoglu's observed preferred chewing side method among the groups (p>0.05) (Table 4).

On the sunflower seed shell cracking test, the subjects preferred the right side more frequently. In all three groups, there was no significant association between the VAS method and the SSSC test in terms of chewing side preference (p>0.05) (Table 5).

Table 5. Relationship between VAS and SSSC in the study groups

Groups		Sunflower Seed Shell Cracking Test: Right n (%)	Left n (%)	Middle of two teeth n (%)	Total n (%)	p
Fully dentate bruxers	Right	13 (68.4)	4 (21.1)	2 (10.5)	19 (43.2)	0.21
	Left	17 (68)	8 (32)	0 (0)	25 (56.8)	
	Total	30 (68.2)	12 (27.3)	2 (4.5)	44 (100)	
Fully dentate non-bruxers	Right	16 (55.2)	10 (34.5)	3 (13.3)	29 (59.1)	0.85
	Left	9 (60)	4 (26.7)	3 (13.3)	15 (34.1)	
	Total	25 (56.8)	14 (31.8)	2 (4.5)	44 (100)	
Non-bruxers with missing and/or restored teeth	Right	16 (61.5)	8 (30.8)	2 (7.7)	26 (59.1)	0.84
	Left	10 (55.6)	7 (38.9)	1 (5.6)	18 (40.9)	
	Total	26 (59.1)	15(34.1)	3 (6.8)	44 (100)	

VAS: Visual Analogue Scale
*Chi-square test (p denotes significance level, *p<0.05: statistically significant.)*

DISCUSSION

There is no universally accepted method for the diagnosis of bruxism, and each method has its own advantages and drawbacks (13). This study was conducted on individuals with “probable” bruxism due to the high cost and relatively difficult accessibility of polysomnographic and electromyographic recordings. The authors used the clinical evaluation criteria in addition to the questionnaire for this study and consider that a much more reliable study group has been established than would be obtained with the "possible" bruxism diagnostic criteria (13, 23).

In most of the physical activities, there is a preference to use one side of the body over the contralateral side with respect to hands, feet, ears and eyes (25, 26). Chewing is no exception and many studies have reported that there may be a preferred chewing side (7, 27).

There are several studies reporting that unilateral chewing is also affected by bruxism (17, 18). In a study, Fujita et al. (17) found a significant association between unilateral chewing and bruxism and stated that unilateral chewing and bruxism are the most common behaviors among parafunctional habits in patients with TMD ($p<0.05$). Consistently, Yeler et al. (18) found that 42% of individuals with TMD were bruxers and reported significant associations between TMD and bruxism and between bruxism and unilateral chewing ($p<0.05$). Ishibashi et al. (28) reported that bruxers with TMD tend to favor one side for chewing over the other compared to non-bruxers with TMD.

Former studies on the impact of environmental factors on chewing side preference (CSP) have yielded contradictory results. Various environmental factors have been examined in those studies, which included asymmetric tooth loss, partial denture, deciduous and mixed dentition, functional occlusal contact areas, head posture, presence of caries, pain and food texture (3, 6, 7, 9, 11, 29, 30).

Haralur et al. (7), Omar et al. (31) and Rovira-Lastra et al. (5) have reported that the chewing side is affected by occlusal parameters, as assessed by the visual point method and masticatory efficiency test respectively. Contrastingly, Pond et al. (8) did not find an association between occlusion and chewing side preference using patient survey method. Oral pain and temporomandibular joint disorders have also been reported to affect CSP in aforementioned studies.

In a study involving 189 individuals from the Israeli population, Nissan et al. (10) investigated chewing side preference using patient questionnaire and the first cycle of gum chewing. The authors reported that local dental parameters such as missing teeth, teeth with implant-supported restoration and complete dentures had no effect on CSP. They also noted a significant association between CSP and hemispheric laterality ($p<0.05$). In another study by Nayak et al. (32) in 240 individuals from the Indian population, chewing side preference as determined by EMG or survey by age groups was not associated with caries in deciduous or permanent teeth.

In the current study, environmental factors such as pain, caries and premature occlusal contact other than missing or restored teeth were eliminated in all groups, which allowed for investigating specifically their effect on chewing side preference and its association with brain laterality. In contrast to Nissan et al.'s report (10), chewing side preference was not significantly associated with brain laterality in individuals with missing or restored teeth in the present study. This discrepancy may be explained by differences in populations studied and methodology. Moreover, since the primary aim of this study was not to investigate the impact of environmental factors on chewing side preference, the exclusion of the individuals who use both sides for chewing represents a limitation in the examination of any effect of environmental factors.

In studies reporting that chewing side preference is influenced by the central nervous system, CSP was found to be associated with hemispheric laterality including handedness, footedness, earedness and eyedness, and this relationship has been explored in diverse populations using different methods (3, 10, 11).

In a South Korean study by Seung-Min Lee et al. (3) in 54 fully dentate individuals without caries aged 25 to 35 years, chewing gum was used as the test food to determine CSP during 30 chewing strokes, and the side with more than 15 strokes was considered as the preferred chewing side. The authors reported that CSP was associated with eye and foot preferences ($p<0.05$) but not with hand and ear preferences ($p>0.05$).

In a study from Turkey by Serel Arslan et al. (11) involving 75 fully dentate individuals (21 to 45 years of age) with no caries, CSP was determined using VAS and found to be significantly correlated with hand, foot, ear and eye preferences ($p<0.05$). In that study, chewing side preference was reported to be centrally controlled.

On the other hand, there are studies reporting that there is no correlation between CSP and lateral dominance (27, 29, 33). Martinez-Gomis et al. (30) found no significant relationship between CSP and hand preference using Optosil silicone tablets as test material in 117 young adults 17 to 47 years of age with natural dentition ($p>0.05$). In a study by Gisel (33), preferences of placing food either on the left or right side of the mouth when starting to eat were examined in 98 children 5 to 8 years of age and then compared with hand preferences. As a result, they found no significant association between handedness and chewing side preference ($p>0.05$). Khamnei et al. (27) analyzed chewing side preference with handedness in 19 healthy young subjects using soft (cake) and hard (walnut) foods using surface EMG recordings from the jaw muscles and reported no significant correlation ($p>0.05$). However, they observed right side dominance for both preferences and suggested that chewing side preference possibly originates from the dominant brain hemisphere.

Previous studies have discussed involvement of many factors in the etiology of bruxism including the central nervous system (34, 35). Whether the unilateral chewing tendency reported among bruxers is also determined centrally was another topic that the current study was interested in examining. In line with aforementioned studies, CSPs were not significantly associated with hand, foot, ear and eye preferences or brain laterality in any of the groups including the bruxers in the present study. As there are no studies in the literature exploring the relationship between chewing side preference and brain laterality in bruxers, a direct comparison could not be made among bruxer populations across studies.

Furthermore, there were very few study subjects with left side dominance in extremity and sensory preferences, which limited the ability of the authors to draw firm conclusions on the correlation of chewing side preferences with brain laterality in left-handed subjects.

As reported by many studies, right-handedness and thus left brain dominance are more prevalent in the general population (5, 10, 36). Studies in different populations have demonstrated that chewing occurs predominantly on the right side (5, 36) and chewing side preference may be centrally regulated (5, 10, 11, 30).

Consistently, results of the current study showed a higher rate of right side preference in extremity use, indicating left brain dominance. However, although chewing side preferences were in the same direction as the extremity and sensory preferences among non-bruxer groups, the lower rate of right side preference and the non-significant association with brain laterality suggest that environmental factors may be involved in these groups.

In the group of bruxers, right-sided extremity and sensory preferences along with a slight tendency to chew on the left side showed no relationship with the dominant brain lobe involved in extremity and sensory preferences ($p>0.05$). However, higher frequency of left side dominance among bruxers compared to the other groups in the current study led us to consider whether different central or environmental factors come into play in that case. The authors think that this differential finding observed in bruxers warrants further studies in larger populations with a balanced distribution of left-handed and right-handed individuals.

To the best of the authors' knowledge, Kazazoglu's method was tested in only one study in comparison to other methods. In a study, Varela et al. (36) compared kinesiography method with Kazazoglu's observed and state preferred chewing side tests for determining chewing side preference and found no significant agreement between the two methods. In the present study, Kazazoglu's method showed low intra-observer agreement and was not significantly associated with VAS ($p>0.05$). Based on these results, it was concluded that Kazazoglu's method is not a reliable method for determining chewing side preference.

In the current study, it was sought whether sunflower seed shell cracking (SSSC) test could serve as a better method to determine CSP than established methods. Although SSSC test was not significantly associated VAS, it showed perfect intra-observer agreement, which was the highest among the methods used. This may also explain the abrasions observed in the area used for cracking sunflower seed shells among individuals with a habit of eating sunflower seeds.

CONCLUSION

In conclusion, there was no relationship between chewing side preference and the dominant brain hemisphere indicated by the extremity and sensory preferences identified. Extremity and sensory preferences of the study sample were predominantly right-sided (dominant left hemisphere). However, right side preference for chewing was less common in the study groups, and even showed left side dominance among bruxer groups. Different central and peripheral mechanisms may be involved in CSP, and further studies are needed to corroborate the current findings. Kazazoglu's method was found to be a non-reliable method to determine CSP and although the sunflower seed shell cracking test was reliable, its validity could not be demonstrated.

Ethics Committee Approval: Approval of the study protocol was granted by the Ethics Committee on Non-Interventional Clinical Trials of Sivas Cumhuriyet University on 14.04.2021 (No. 2021–04/06).

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