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ORIGINAL RESEARCH

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Comparative evaluation of the effect of three different methods used in the management of sleep bruxism in children: a randomized controlled trial

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Abstract

Background: Bruxism is defined as involuntary, repetitive masticatory muscle activity, which is characterized by clenching or grinding. The objective of our study was to comparatively evaluate the effectiveness of Kinesio tape, occlusal splint and exercise in reducing myofascial pain resulting from bruxism in children with sleep bruxism. **Methods**: A total of 47 children presenting with symptoms of sleep bruxism were randomly assigned to one of three intervention groups. The study groups were designated as KT (Kinesio tape group), OS (occlusal splint group) and EG (exercise group). In all groups, the Wong-Baker Faces Pain Rating Scale (WBFPS), maximum mouth opening and pressure pain threshold of the bilateral masseter and temporal muscles were assessed before intervention and at the end of the first and fifth weeks. Additionally, ultrasonographic evaluation of the temporal and masseter muscles was conducted at these time points. **Results**: The evaluation of the groups in terms of gender and age revealed no statistically significant difference ($p > 0.05$). Similarly, no statistically significant difference was observed between the groups in terms of WBFPS value and mouth opening values ($p > 0.05$). With regard to masseter muscle thickness, the exercise group exhibited lower values than the other two groups at baseline, Week 1 and Week 5. In contrast, the OS group demonstrated higher temporal muscle thickness values than the other two groups at Week 1. No statistically significant difference was observed between the groups in terms of pressure pain threshold of the masseter and temporal muscles at baseline, Week 1 and Week 5 ($p > 0.05$). **Conclusions**: It has been demonstrated that the use of Kinesio tapes in children with sleep bruxism is at least as effective as occlusal splints. Furthermore, the tapes are biocompatible, require minimal effort to apply, and represent an optimal option when occlusal splints are contraindicated. **Clinical Trial Registration**: The study was registered with ClinicalTrials.gov as: NCT06232993.

Keywords

Kinesio tape; Sleep bruxism; Pediatrics; Occlusal splint; Myofascial pain

1. Introduction

Bruxism is defined as involuntary, repetitive masticatory muscle activity, which is characterized by clenching or grinding [1]. Bruxism is classified into two categories based on its occurrence during sleep and wakefulness [2]. Awake bruxism is defined as daytime masticatory muscle activity, characterized by repetitive or prolonged tooth contact or the forward or backward movement of the lower jaw [1, 3]. Sleep bruxism, defined as rhythmic (phasic) or non-rhythmic (tonic) chewing muscle activity during sleep, is not a movement disorder or sleep disorder in healthy individuals [1].

Bruxism has been linked to a number of complications, including irregularities of the temporomandibular joint, damage to muscle and periodontal tissues, myofascial pain and abnormal tooth wear [2]. It is hypothesized that idiopathic (occurring in the absence of any accompanying medical condition) or iatrogenic (resulting from disease or drug use) factors may contribute to the etiology of bruxism [4]. Some researchers posit that psychological factors frequently contribute to the etiology of both bruxism during sleep and wakefulness [5].

It is established that bruxism is more prevalent in children than in adults and that its prevalence declines with age [6]. The prevalence of bruxism is reported to range from 13% to 49% [7]. It has been documented that the onset of bruxism symptoms in children typically occurs between the ages of four and eight years, with a subsequent increase in prevalence between the ages of ten and fourteen years [8].

The evaluation of bruxism employs both a non-instrumental and an instrumental approach [1]. In the non-instrumental approach, self-report (questionnaires, oral history) and clinical

examination are assessed. In contrast, in the instrumental approach, masticatory muscle activity can be assessed using electromyographic (EMG) recordings and polysomnography (PSG) [1].

Detection of bruxism may be accomplished through the use of a variety of methods, including subjective observations, medical history, clinical examination, evaluation with intraoral devices, recording of muscle activity, electromyography and polysomnography [1, 7]. According to the diagnostic criteria set by the American Academy of Sleep Medicine (AASM), individuals exhibiting sleep bruxism may present with a number of characteristic symptoms. These may include reports from a parent or sibling of teeth grinding sounds occurring at least three to five nights per week during the previous three to six months. Additionally, clinical evaluation may reveal evidence of abnormal tooth wear and hypertrophy of the masseter muscle, which may be caused by involuntary clenching. Furthermore, individuals may experience transient or morning jaw discomfort, pain, fatigue and headaches [9].

In the management of bruxism in children, a variety of methods are commonly employed, including occlusal appliances, physical therapy, Kinesiotherapy, massage, infrared therapy, low-level laser therapy and acupuncture [10]. Occlusal appliances are acrylic aligners applied to the upper or lower jaw that serve to enhance the functionality of the temporomandibular joint (TMJ), facilitate relaxation of the surrounding muscles, safeguard the teeth against abrasion, alleviate excessive stress on the joint and restore the condyles to their optimal position [11]. Hard occlusal splints represent the most commonly utilized method for the management of bruxism [11]. Occlusal splints are a common intervention method for bruxism. However, alternative methods are being investigated due to the contraindications associated with its use, including a severe gag reflex, epilepsy, high risk of airway obstruction and orthodontic appliance use [12]. One of the alternative methods employed in the management of bruxism is the application of Kinesio tape (KT). KT application is a technique that is readily implemented by adhering tape to the skin in alignment with the pertinent muscles. This approach has been demonstrated to enhance muscle stability and nerve conduction by impeding aberrant muscle movements. The application of KT has been demonstrated to alleviate myofascial pain and can be employed in conjunction with other therapeutic modalities to mitigate symptoms of bruxism [13].

Sleep bruxism in children is frequently linked to the occurrence of nightmares, sleepwalking and bedwetting [14]. The objective of our study was to comparatively evaluate the effectiveness of Kinesio tape, occlusal splint and exercise application in reducing myofascial pain in children with sleep bruxism.

The objective of this study was to ascertain whether the application of Kinesio tape would prove more beneficial than the use of occlusal splints or exercises in reducing myofascial pain in children with sleep bruxism. Furthermore, it was hypothesized that the interventions would result in changes in muscle thickness and pressure pain threshold.

2. Material and methods

This study is a randomized controlled clinical trial that was conducted at Adıyaman University Faculty of Dentistry between 15 August 2022, and 30 January 2023. Clinical Trial Registration Number: NCT06232993.

This study was conducted in accordance with the ethical standards set forth in the Helsinki Declaration. Prior to participation, all children and their parents or legal guardians provided informed consent.

2.1 Participant selection

In the present study, 65 children presenting with nocturnal clenching complaints were evaluated by the Department of Pedodontics of the Faculty of Dentistry at our University. Participants underwent a combination of intraoral and extraoral examinations by a pediatric dentist specialist. These data were then integrated with the anamnesis obtained from the child and parents to diagnose sleep bruxism. In order to diagnose sleep bruxism, it is necessary to observe a number of symptoms. These include the children's own account of teeth clenching or grinding, the presence of abnormally worn teeth, the hearing of sounds related to bruxism and the experience of muscle discomfort in the mandible while sleeping for the last six months, and perceiving sounds consistent with clenching or grinding while in a state of sleep on at least five days of the past six months. Additionally, there should be pain or tenderness in the TMJ area or jaw muscles upon waking up in the morning.

The study included children aged 6–11 years [1] who were presented to the clinic and exhibited at least one symptom of sleep bruxism. The participants were children who agreed to take part in the study [15], had not been previously treated for sleep bruxism [16] and were able to cooperate [16].

The study excluded children with maxillofacial trauma. The study also excluded children with special needs (psychiatric or neurological disorders, systemic disorders) [16], children with a history of allergies or asthma [15], children using orthodontic appliances [15] and children taking anti-inflammatory drugs, muscle relaxants, corticosteroids or anticonvulsants, or antidepressants [17], children with dental abscesses or fistulae, children using fixed or removable placeholder appliances [16] and children with visual impairment (changes in masseter muscle thickness) [18].

2.2 Study design

To determine the intervention groups, 54 children randomly selected a ball from a box containing three different colored balls, with 18 balls of each color.

The study group in Group I underwent Kinesio taping, while the study group in Group II was fitted with occlusal splints. The exercise group in Group III was instructed in jaw exercises and relaxation techniques. In the present study, the groups were formed randomly.

KT Group: Kinesio tape was applied bilaterally to the temporomandibular joint (TMJ) by the parent at night before bedtime. To ensure standardization in Kinesio tapes, the same color, same brand and same type of tapes were provided to the parents. The parent was provided with a detailed explanation

of the tape application procedure at the clinic. The tape was divided into two pieces, each measuring approximately two inches (approximately 5 cm) in length and one inch (approximately 2.5 cm) in width. These pieces were cut in an "I" shape, as per the instructions outlined in the user manual. The ends of the tape were then pulled and placed diagonally across the TMJ area. The second piece was positioned diagonally above the first piece, forming an "X" shape over the joint. The "Kinesio tape X" was utilized due to the presence of muscles affecting two joints and extending to multiple regions [19]. The tapes were removed by the parent when the child woke up and reapplied every night before bedtime for a period of five weeks [20], as illustrated in Fig. 1. To assess the efficacy of participant-performed daily Kinesio taping, we requested that they record videos of themselves performing the procedure and provided a control measure through video examination.

OS Group: A plaster model was obtained from the upper jaw of the children in this group by taking impressions with alginate. In the laboratory, a 0.5 mm [20] thick hard thermoplastic acrylic plate was adapted to the model and prepared by pressing to cover the occlusal, buccal and lingual surfaces of the teeth (Fig. 2) [20]. To prevent the participant from triggering the gag reflex, the plate was not extended to the palate. The prepared plate was then adapted to the participant's mouth. The participant was instructed to wear the splint every night from bedtime until waking up in the morning in five weeks time.

EG Group: Participants in this group were instructed in a home exercise program by the same physiotherapist. The program included techniques for joint and muscle relaxation, as well as isometric side shift, isometric protrusion and isometric opening exercises for the temporomandibular joint region. Additionally, the children were instructed in relaxation techniques, including maintaining an upright posture with the head and shoulders, avoiding forward slouching, and remembering the resting position of the lips, teeth and tongue [21].

Exercise program:

1. Joint and muscle relaxation: The tongue is positioned as far posteriorly as possible on the palate and, with the tongue in this position, the mouth is opened as widely as possible.

2. Isometric side shift: The index and middle fingers are positioned in conjunction with one another in proximity to the chin. The chin is pressed against the fingers and maintained in this position for a period of 10 seconds, after which the fingers are released. This exercise is performed separately for each side of the chin.

3. Isometric protrusion is performed by extending the chin forward while maintaining the position of two to three fingers in front of the chin for a period of ten seconds, after which the fingers are relaxed.

4. The isometric opening exercise involves positioning the fist beneath the chin and then forcing the chin to open. This is maintained for a period of 10 seconds, after which the chin is allowed to relax [22].

The exercise regimen was designed to be performed two times per day, with ten repetitions and three sets for a total of five weeks. Information forms, including exercise logs, were provided to the children. To assess the efficacy of the children's daily exercise routines, we requested that parents record daily videos of the children exercising and subsequently conducted a control examination of the videos.

The maximum mouth opening was evaluated by a maxillofacial surgeon. The child was asked to open and close their mouth as wide as possible on two occasions. For the third instance, the child was instructed to open their mouth as wide as possible and to maintain this position without closing it. The distance between the incisal edges of the upper and lower incisors was then measured and recorded with the assistance of a ruler.

A series of assessments were conducted on all groups prior to interventions and at the conclusion of the first and fifth weeks [20], including the Wong-Baker Faces Pain Rating Scale (WBFPS) [23], maximum mouth opening and pressure pain threshold of the bilateral masseter and temporal muscles, as well as ultrasonographic evaluation of the temporal and masseter muscles.

In the present study, masseter and temporalis muscle thicknesses were evaluated using a GE Logiq S7 brand ultrasonography device (GE Healthcare; Milwaukee, WI, USA) by a radiologist (MR) with 17 years of experience, employing high-frequency superficial probes. During the evaluation of the children, bilateral masseter muscle measurements were conducted in the supine position with the children's neck in a neutral position and parallel to the mandibular corpus in the axial plane. This approach ensured standardization of probe position and localization between children. Furthermore, the temporalis muscle was assessed bilaterally by measuring the distance between the superficial and deep fascia of the muscle at a point approximately 2 cm above the zygomatic arch, in a direction parallel to the zygomatic arch (Fig. 3).

Pressure algometry is a semiquantitative method used to assess pressure pain sensitivity in tissues, localizing sensitive areas, trigger points and abnormal sensitivity over muscles and bones [24, 25]. The sensitivity of the bilateral temporal muscle and masseter muscle (pressure pain threshold-PPT) was measured by the same physiatrist using a digital algometer device (JTECH Medical, Midvale, UT, USA). The values obtained from the pressure pain threshold (PPT) assessment were reported in kilograms per centimeter squared (kg/cm^2).

Once the children and their parents had been apprised of the procedure, they were instructed to assume a seated position in a chair and permitted to relax fully. The midpoint of the temporal muscle was identified through palpation, as were the origin, midpoint and insertion of the masseter muscle. The metal disk of the pressure algometer was positioned perpendicular to the marked area, and pressure was gradually increased. When the participant closed their eyes and exhibited signs of pain or discomfort, the physiatrist was instructed to apply pressure to the arm that was fixed in place by the participant's head. At this point, the pressure was halted and documented.

For the temporal muscle, a single measurement was taken and recorded. Given that the masseter muscle has three parts, three measurements were taken and the mean of these three values was calculated and recorded. Measurements were recorded bilaterally.

In the present study, sleep bruxism was evaluated by means of a methodical interrogation of the masticatory muscles upon awakening in the morning. This assessment was conducted by means of the Wong-Baker FACES®Pain Rating Scale

FIGURE 1. Kinesio tape application in a child.

FIGURE 2. Occlusal splint in a child.

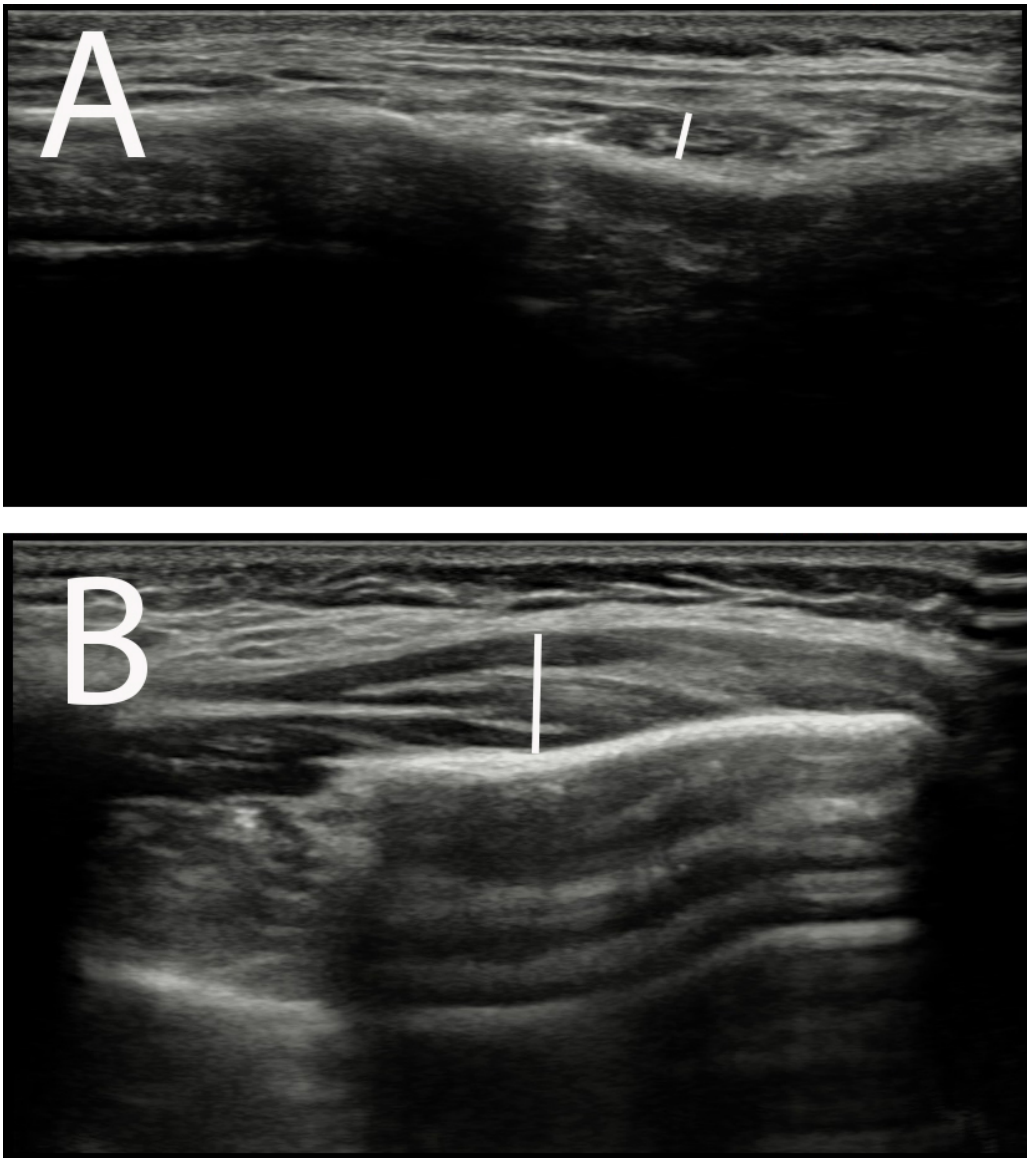

FIGURE 3. Masseter and temporalis superficialis muscles, the widest distance between the superficial and deep fascia for both muscles was measured in the axial plane. (A) Masseter. (B) Temporalis superficialis.

(WBFPS). In order to differentiate myofascial pain from other types of pain, palpation of the masticatory muscles was performed.

The Wong-Baker Faces Pain Rating Scale (WBFPS) was employed as a means of assessing the participant's pain status at three distinct time points: prior to interventions, and at one and five weeks following the initiation of interventions (Fig. 4 (Ref. [23])). The WBFPS is a reliable and valid scale that employs a combination of numbers and pictures to assess pain. The scale ranges from 0, indicating no pain, to 10, indicating the most severe pain. Participants are instructed to select the facial expression that best represents their pain and the score is recorded.

The efficacy of the intervention regimen was enhanced by the use of daily videos filmed by the children's parents, which served to reinforce the prescribed course of action and ensure compliance.

In the studies, children receiving care from physiotherapists and maxillofacial surgeons were randomly evaluated in different clinics without the knowledge of each other. The data were entered by other specialists without knowing the identity of the children.

Each specialist performed the measurement related to their field of expertise. The pediatric dentist was responsible for conducting oral examinations of the participants and inquiring about their medical histories. The maxillofacial surgeon measured the maximum mouth opening. The physical therapist evaluated the PPT of the masticatory muscles. The radiologist evaluated the thickness of the masticatory muscles.

2.3 Statistical analysis

The data obtained in this study were analyzed with IBM SPSS Statistics Version 27.0.1.0 version (Chicago, IL, USA). The G*Power 3.1.9.6 software (Heinrich Heine University Düsseldorf, Düsseldorf, NRW, Germany) was also employed. While investigating the normal distribution of the variables, Shapiro Wilk's was used due to the number of units. While interpreting the results, 0.05 was used as the significance level; in case of p

FIGURE 4. The Wong-Baker Faces Pain Rating Scale (WBFPS) [23].

< 0.05, it is stated that the variables have a normal distribution and in case of $p > 0.05$, it is stated that the variables do not have a normal distribution.

When examining the differences between the groups, the Mann-Whitney U test was used since the variables were not normally distributed. In the context of examining multiple comparisons between groups, the One-Way Analysis of Variance (ANOVA) *Post Hoc* Test was employed due to the assumption of a normal distribution among the variables. Conversely, the Kruskal-Wallis test was utilized for parameters that did not adhere to a normal distribution.

When the groups were evaluated among themselves, the Paired Samples test was used in comparisons with normal distribution, while the Wilcoxon test was used in groups with non-normal distribution. Chi-square analysis was applied to analyze the relationships between groups of nominal variables.

3. Results

3.1 Participants

In the present study, the data of 47 children (mean age: 8.36 years) were analyzed after the exclusion of 18 of the 65 children initially enrolled. The Consolidated Standards of Reporting Trials (CONSORT) diagram is presented in Fig. 5.

In the present study, 60% of the children with bruxism exhibited myalgia in the masticatory muscles, 10% demonstrated TMJ arthralgia and 90% displayed signs of tooth wear. In the present study, 19 participants initially exhibited no signs of pain upon palpation of the masticatory muscles in the morning (*i.e.*, 0 according to WBFPS).

The investigation revealed no statistically significant relationship between gender and group affiliation ($p > 0.05$). Similarly, no statistically significant differences were observed between the groups with respect to age ($p > 0.05$) (Tables 1a,1b).

3.2 Assessment of WBFPS, mouth opening, muscle thickness, muscle pressure pain threshold

3.2.1 In terms of WBFPS scale values within the group

- A decline in the Wong-Baker Faces Pain Rating Scale (WBFPS) values over time was observed in the OS group. This decrease was not statistically significant when comparing baseline to Week 1 ($p > 0.05$), yet a statistically significant difference was identified between Week 1 and Week 5, as well as between baseline and Week 5 ($p < 0.05$) (Table 2a).

- A decline in WBFPS values over time was observed in the KT group. A statistically significant difference was identified between baseline and Week 1, as well as between baseline and Week 5 ($p < 0.05$). However, no statistically significant difference was found between Week 1 and Week 5 ($p > 0.05$) (Table 2a).

- A decline in WBFPS values over time was observed in the EG group. A statistically significant difference was identified between baseline and Week 1, as well as between baseline and Week 5 ($p < 0.05$). However, no statistically significant difference was found between Week 1 and Week 5 ($p > 0.05$) (Table 2a).

3.2.2 In terms of mouth openness values within the group

- As time progressed, the mouth opening values in the OS group underwent an increase. This increase was not accompanied by a statistically significant difference between the baseline and Week 1 values ($p > 0.05$). However, a statistically significant difference was observed between Week 1 and Week 5, as well as between the baseline and Week 5 values ($p < 0.05$) (Table 2b).

- As time progressed, the mouth opening values in the KT group underwent an increase. This increase was not accompanied by a statistically significant difference between the baseline and Week 1 values or between the baseline and Week 5 values ($p > 0.05$). However, a statistically significant difference was observed between the baseline and Week 5 values ($p < 0.05$) (Table 2b).

- As time progressed, the mouth opening values in the EG group underwent an increase. A statistically significant difference was identified between the baseline and Week 1 and Week 5 values ($p < 0.05$) (Table 2b).

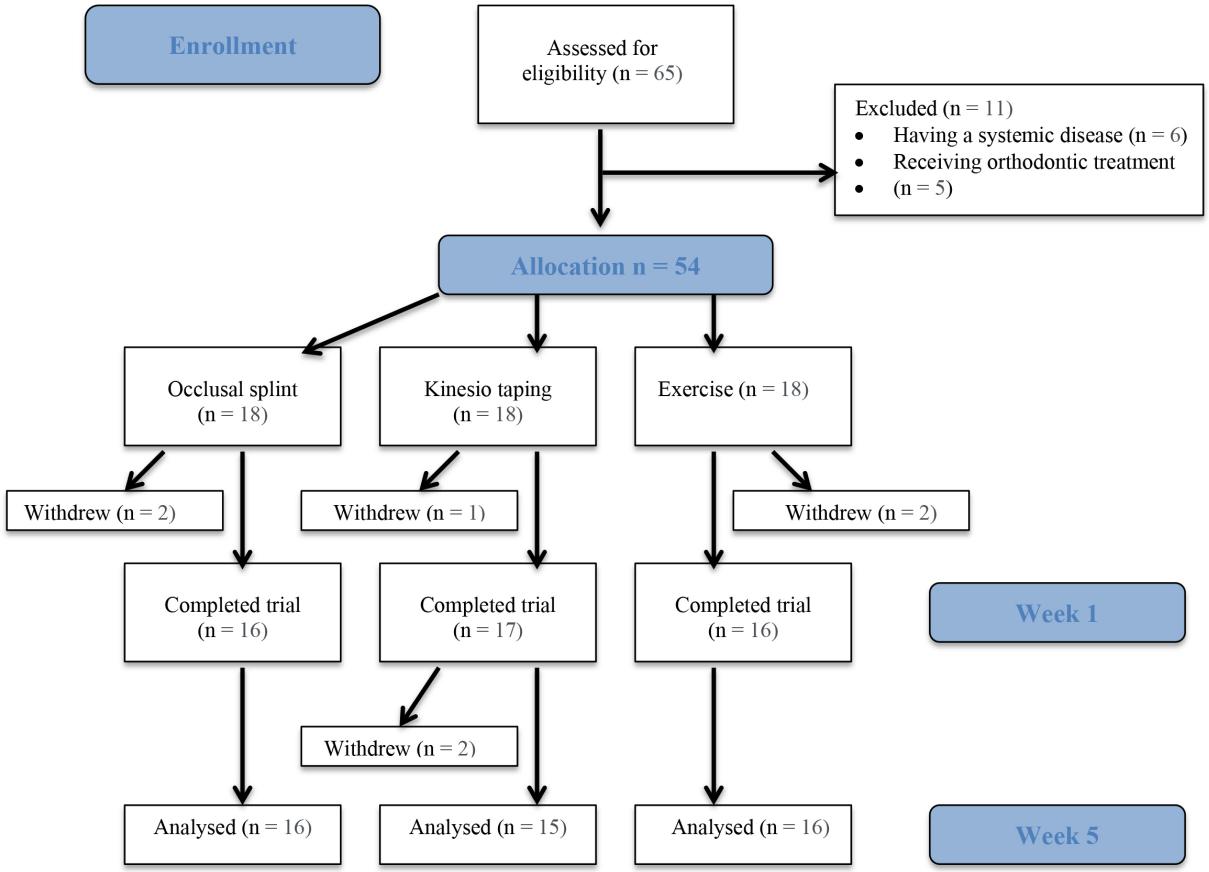

FIGURE 5. A flow diagram.

TABLE 1a. The relationship between genders in groups.

	Groups								
	OS		KT		EG		Total		*p* value
	n	%	n	%	n	%	n	%	
Sex									
Female	5	31.3	6	40	6	37.5	17	36.2	0.871
Male	11	68.7	9	60	10	62.5	30	63.8	
Total	16	100	15	100	16	100	47	100	

n: Count; OS: occlusal splint group; KT: Kinesio tape group; EG: exercise group.
The statistical analysis of gender distribution was conducted using the Chi-square test.
A p-value less than 0.05 was considered statistically significant.

TABLE 1b. The relationship between age in groups.

Groups	Age (yr)					
	n	Mean	SD	Min	Max	*p* value
OS	16	8.31	1.57	6	11	
KT	15	8.53	0.91	7	11	0.829
EG	16	8.25	1.61	6	11	
Total	47	8.36	1.38	6	11	

SD: Standard Deviation; n: Count; OS: occlusal splint group; KT: Kinesio tape group; EG: exercise group.
Mann Whitney U test was used for statistical analysis in age values.
$p < 0.05$ indicates statistical difference.

TABLE 2a. The relationship between WBFPS values in groups.

WBFPS	Groups		
	OS (n = 16)	KT (n = 15)	EG (n =16)
	Mean ± SD	Mean ± SD	Mean ± SD
Start-up	2.00 ± 2.52	2.26 ± 2.12	2.00 ± 1.93
Week 1	1.00 ± 1.63	1.20 ± 1.65	1.25 ± 1.77
Week 5	0.25 ± 0.68	0.53 ± 0.91	0.75 ± 1.61
		Within-group Wilcoxon test *p* values	
Baseline–Week 1	0.054	0.005	0.034
Week 1–Week 5	0.034	0.096	0.206
Baseline–Week 5	0.010	0.006	0.008

SD: Standard Deviation; n: Count; OS: occlusal splint group; KT: Kinesio tape group; EG: exercise group; WBFPS: Wong-Baker Faces Pain Rating Scale.
$p < 0.05$ indicates statistical difference.

TABLE 2b. The relationship between mouth opening values in groups.

Mouth Opening (mm)	Groups		
	OS (n = 16)	KT (n = 15)	EG (n = 16)
	Mean ± SD	Mean ± SD	Mean ± SD
Baseline	42.50 ± 6.51	43.40 ± 4.88	40.00 ± 5.01
Week 1	44.68 ± 5.83	44.33 ± 4.68	41.93 ± 4.07
Week 5	45.87 ± 5.36	45.73 ± 3.43	44.37 ± 3.30
		Within-group Paired Samples test *p* values	
Baseline–Week 1	0.066	0.068	0.033
Week 1–Week 5	0.029	0.101	0.005
Baseline–Week 5	0.011	0.004	0.001

SD: Standard Deviation; n: Count; OS: occlusal splint group; KT: Kinesio tape group; EG: exercise group.
$p < 0.05$ indicates statistical difference.

3.2.3 In terms of masseter muscle thickness values within the group

- The investigation revealed that there was an absence of statistically meaningful change in the thickness of the masseter muscle in the OS cohort. Consequently, there was no statistically significant discrepancy between the baseline measurements, the measurements obtained after one week and the measurements obtained after five weeks ($p > 0.05$) (Table 3a).

- A comparison of the masseter muscle thickness values revealed no statistically significant differences among the three time points (baseline, Week 1 and Week 5) in the KT group ($p > 0.05$) (Table 3a).

- An increase in masseter muscle thickness values over time was observed in the experimental group (EG). A statistically significant difference was found between the baseline and Week 1 measurements, as well as between the baseline and Week 5 measurements ($p < 0.05$). However, no statistically significant difference was found between the measurements from Week 1 and Week 5 ($p > 0.05$) (Table 3a).

3.2.4 Temporal muscle thickness values within the group

- Temporal muscle thickness values in the OS group increased only at Week 1, which resulted in a statistically significant difference between Week 1 and Week 5 ($p < 0.05$). However, there was no statistically significant difference between baseline and Week 1 and Week 5 ($p > 0.05$) (Table 3b).

- The analysis revealed no statistically significant differences in temporal muscle thickness values among the subjects in the KT group (Table 3b). This finding indicates that there was no statistically significant difference between baseline values, values at Week 1 and values at Week 5 ($p > 0.05$).

- In the EG group, temporal muscle thickness values increased only at Week 1. Consequently, a statistically significant difference was observed between Week 1 and Week 5 ($p < 0.05$). However, no statistically significant difference was found between the baseline and Week 1 or Week 5 ($p > 0.05$) (see Table 3b).

TABLE 3a. The relationship between masseter muscle thickness values in groups.

Masseter Muscle Thickness	Groups		
	OS (n = 32)	KT (n = 30)	EG (n = 32)
	Mean ± SD	Mean ± SD	Mean ± SD
Baseline	8.45 ± 0.67	8.36 ± 0.92	7.71 ± 1.11
Week 1	8.63 ± 0.95	8.36 ± 0.87	7.89 ± 0.98
Week 5	8.61 ± 0.77	8.43 ± 0.82	7.91 ± 0.84
	Within-group Paired Samples test *p* values		
Baseline–Week 1	0.151	0.962	0.001
Week 1–Week 5	0.836	0.112	0.709
Baseline–Week 5	0.141	0.387	0.015

SD: Standard Deviation; n: Count; OS: occlusal splint group; KT: Kinesio tape group; EG: exercise group.
$p < 0.05$ indicates statistical difference.

TABLE 3b. The relationship between temporal muscle thickness values in groups.

Temporal Muscle Thickness	Groups		
	OS (n = 32)	KT (n = 30)	EG (n = 32)
	Mean ± SD	Mean ± SD	Mean ± SD
Baseline	5.20 ± 0.57	4.97 ± 0.62	5.00 ± 0.63
Week 1	5.30 ± 0.59	4.91 ± 0.50	5.16 ± 0.63
Week 5	5.14 ± 0.61	4.93 ± 0.45	5.00 ± 0.48
	Within group Paired Samples test *p* values		
Baseline–Week 1	0.233	0.508	0.055
Week 1–Week 5	0.008	0.777	0.016
Baseline–Week 5	0.373	0.528	1.000

SD: Standard Deviation; n: Count; OS: occlusal splint group; KT: Kinesio tape group; EG: exercise group.
$p < 0.05$ indicates statistical difference.

3.2.5 In terms of masseter muscle pain values within the group

- An increase in the values indicating muscle pain in the masseter muscle was detected in the OS group. However, no statistically significant difference was found between the baseline, Week 1 and Week 5 measurements ($p > 0.05$) (Table 4a).

- A meticulous examination of the data reveals that there was no statistically significant difference in the values of the masseter muscle pain measurements in the KT group. Consequently, there was no statistically significant difference between the baseline, Week 1 and Week 5 measurements ($p > 0.05$) (Table 4a).

- An increase in the values of the masseter muscle pain measurements was observed over time in the experimental group (EG). A statistically significant difference was found between the baseline and Week 1 measurements, as well as between the baseline and Week 5 measurements ($p < 0.05$). However, no statistically significant difference was found between the measurements from Week 1 and Week 5 ($p > 0.05$) (Table 4a).

3.2.6 Temporal muscle pain values within the group

- Temporal muscle pain values increased in the OS group; however, there was no statistically significant difference between baseline and Week 1 ($p > 0.05$). Nevertheless, there was a statistically significant difference between baseline and Week 5, as well as between Week 1 and Week 5 ($p < 0.05$) (Table 4b).

- Temporal muscle pain values increased in the KT group. No statistically significant difference was found between baseline and Week 1, or between Week 1 and Week 5 ($p > 0.05$). However, a statistically significant difference was found between baseline and Week 5 ($p < 0.05$) (Table 4b).

- An increase in temporal muscle pain values was observed in the EG group. However, this increase was not statistically significant between Week 1 and baseline values ($p > 0.05$). Nevertheless, a statistically significant difference was found between the baseline and Week 5 values, as well as between Week 1 and Week 5 values ($p < 0.05$) (Table 4b).

TABLE 4a. The relationship between masseter muscle pressure pain threshold values in groups.

Masseter Muscle PBT	Groups			Multiple comparisons between groups
	OS (n = 32)	KT (n = 30)	EG (n = 32)	
	Mean ± SD	Mean ± SD	Mean ± SD	*p* values
Baseline	7.10 ± 1.03	6.76 ± 1.88	6.66 ± 1.01	0.206
Week 1	7.10 ± 1.49	7.00 ± 0.98	7.10 ± 0.88	0.911
Week 5	7.33 ± 1.32	6.97 ± 1.23	7.23 ± 1.00	0.619
		Within-group *p* values		
Baseline–Week 1	0.922	0.422	0.031	
Week 1–Week 5	0.221	0.854	0.557	
Baseline–Week 5	0.378	0.442	0.018	

SD: Standard Deviation; n: Number; PBT: Pressure Pain Threshold; OS: occlusal splint group; KT: Kinesio tape group; EG: exercise group.
$p < 0.05$ indicates statistical difference.

TABLE 4b. The relationship between temporal muscle pressure pain threshold values in groups.

Temporal Muscle PBT	Groups			Multiple comparisons between groups
	OS (n = 32)	KT (n = 30)	EG (n = 32)	
	Mean ± SD	Mean ± SD	Mean ± SD	*p* values
Baseline	7.62 ± 1.23	7.20 ± 1.11	7.63 ± 1.31	0.294
Week 1	7.85 ± 1.33	7.32 ± 1.66	7.72 ± 0.88	0.268
Week 5	8.43 ± 1.62	7.76 ± 1.12	8.28 ± 1.08	0.114
		Within-group *p* values		
Baseline–Week 1	0.295	0.718	0.688	
Week 1–Week 5	0.026	0.184	0.009	
Baseline–Week 5	0.001	0.049	0.016	

SD: Standard Deviation; n: Number; PBT: Pressure Pain Threshold; OS: occlusal splint group; KT: Kinesio tape group; EG: exercise group.
$p < 0.05$ indicates statistical difference.

4. Discussion

Sleep bruxism is a prevalent clinical condition that results in tooth wear, headaches and facial muscle pain during mastication [26]. In children, it is characterized by a constricted mouth opening. This condition is regarded as a behavioral issue that necessitates monitoring and management [27]. The present study aimed to comparatively evaluate the effectiveness of Kinesio tape, occlusal splint and exercise in reducing myofascial pain resulting from bruxism in children with sleep bruxism. It was found that the use of Kinesio tapes in children with sleep bruxism is at least as effective as occlusal splints.

The management of bruxism in children represents a challenging process that necessitates the collaboration of the physician, the parent and the child [2]. Occlusal splint application represents the most prevalent intervention modality for bruxism. It offers protection against abrasion of the antagonist teeth during the deciduous and mixed dentition period, while also enhancing patient comfort by reducing masseter muscle activity [2, 28]. The utilization of occlusal splints has been demonstrated to be an efficacious intervention for the alleviation of sleep-related symptoms, with the exception of sleep bruxism [29]. In the construction of occlusal splints, two principal categories of materials may be employed: those that are hard and those that are soft [15]. While some researchers have posited that there is no discernible difference between hard and soft occlusal splints with respect to intervention outcomes, others have put forth the hypothesis that soft splints may precipitate parafunctional activity [30, 31]. In our study, an occlusal splint design with indentations and protrusions was deemed preferable to a flat occlusal surface, as it allowed for greater adaptation to the individual's existing occlusion, thus avoiding any potential changes or premature contact.

Akat *et al*. [32] conducted a study in which three different occlusal splints were applied to individuals diagnosed with bruxism: a soft splint, a hard splint and a semi-soft splint. The researchers concluded that the most notable alteration in masseter muscle thickness was attributable to the use of a hard

occlusal splint. Additionally, this intervention was employed in the management of individuals with bruxism within the study.

The application of therapeutic exercises for the management of muscle discomfort associated with bruxism has been demonstrated to effectively reduce pain and muscle spasms within the masticatory muscles, enhance muscle strength and facilitate tissue regeneration. The exercise in question is regarded as the optimal initial management for bruxism, given its numerous advantages. Chief among these is its ease of application, coupled with the fact that no specialized equipment is required. A review of the literature reveals the existence of studies that compare the efficacy of therapeutic exercises with that of occlusal splints [33–35]. Nevertheless, no study has been identified that compares the efficacy of exercise, occlusal splints and Kinesio tape in the management of sleep bruxism in children.

In their study, Keskinrüzgar *et al*. [20] compared the efficacy of occlusal splint and Kinesio tape applications for the management of bruxism. After a five-week period, they reported that both interventions demonstrated comparable outcomes [20]. The application of both methods resulted in an increase in the pain threshold in the masseter and temporal muscles, as well as an increase in mouth opening. Additionally, a reduction in the visual analog scale (VAS) value was observed. Based on the findings of this study, it can be concluded that Kinesio tape application may serve as an alternative method for the management of sleep bruxism. The results of our study indicate a reduction in WBFPS values and an increase in maximum mouth opening following the application of an occlusal splint, Kinesio tape and exercise therapy for a period of five weeks in children diagnosed with sleep bruxism.

Kinesio taping represents an alternative intervention option for individuals with bruxism who are unable to use occlusal splints. It has been demonstrated to reduce myofascial pain and increase masseter muscle activity and the amount of mouth opening [20]. The mechanism of action of the Kinesio tape is to facilitate the healing process by inducing micro-convulsions beneath the dermal layer, thereby increasing lymphatic circulation and blood flow in the affected region [12]. In our study, the Kinesio tape was the preferred method for children with sleep bruxism due to its non-invasive nature and ability to reduce muscle pain, thereby facilitating recovery.

The evaluation of masseter muscle thickness with ultrasound revealed no change between the groups with occlusal splint and Kinesio tape application. Conversely, an increase in masseter muscle thickness was observed in the group with exercise therapy. In a study in which masseter muscle thickness was evaluated via ultrasonography in children with bruxism, it was observed that the masseter muscle was thicker in children with bruxism bilaterally than in healthy children [36]. In their study, Uçar and colleagues employed Rocabado's 6 × 6 exercise in the management of individuals with bruxism [37]. The results of the study indicated a reduction in masseter muscle elasticity and pain levels, while no discernible change was observed in masseter muscle thickness when compared to the exercise group. In the present study, we employed a methodology whereby we measured pain or changes in the thickness of the jaw muscles in individuals with bruxism while they were awake. This approach may be related to the presence of bruxism while awake. However, further studies on this subject are needed.

It has been demonstrated in scientific studies that individuals who suffer from bruxism may exhibit signs of muscular hypertrophy in the masticatory muscles [38]. Eren *et al*. [39] observed that masseter muscle thickness was greater in individuals without bruxism compared to those with the condition, while temporal muscle thickness was comparable between the two groups. Additionally, Akat *et al*. [32] observed that the mean masseter muscle thickness values were elevated in individuals diagnosed with bruxism relative to those in a healthy cohort. The results of our study demonstrated that, following the implementation of occlusal splints and exercise therapy, there was a notable increase in temporal muscle thickness values during the initial week of observation. Conversely, the application of Kinesio tape did not elicit a comparable degree of change. In contrast with the findings of our study, other research has indicated that there is no significant difference in the thickness of masticatory muscles between individuals with bruxism and those who are healthy [40, 41]. The time required for dimensional changes in muscles to occur in individuals with bruxism is considerable. However, the limitations of our study, which was conducted in children, preclude the possibility of observing the requisite changes in muscles.

In a study conducted on young individuals with bruxism and healthy individuals, it was observed that the prevalence of pain on palpation bilaterally in the masseter and temporal muscles was higher in young people with bruxism [39]. The results of our study indicated that the masseter muscle pressure pain threshold value increased following the application of an occlusal splint and exercise regimen. However, no significant change was observed following the application of Kinesio tape. The temporal muscle pressure pain threshold value demonstrated an increase over time in all three groups. In their study, Yazici *et al*. [42] evaluated the efficacy of Kinesio taping following a single session of manual therapy or manual therapy in individuals with bruxism. The study revealed a notable reduction in bilateral masseter muscle thickness and stiffness, as well as a considerable decline in masseter and temporal muscle pressure pain threshold in the Kinesio tape-treated group. Additionally, the researchers proposed that Kinesio tape application, when combined with manual therapy, could serve as an expedient intervention for acute pain in individuals with bruxism.

There is currently no definitive management method for children with sleep bruxism. A variety of management modalities are employed in accordance with the specific circumstances. Given the potential for invasive procedures to induce anxiety in children, the utilization of straightforward and non-invasive techniques is strongly encouraged whenever feasible. In individuals with sleep bruxism, Kinesio tape application has been demonstrated to be at least as effective as occlusal splints. It is biocompatible, easy to apply, and represents an ideal management method when occlusal splints are contraindicated.

The occlusal splint, exercise regimen and Kinesio taping technique utilized in the management of individuals with brux-

ism may also elicit a placebo effect. This phenomenon represents a potential limiting factor in the interpretation of the results of our study.

A limitation of this study is that the use of Kinesio tape in children with sleep bruxism may pose an allergy risk. As the methods used in the management of sleep bruxism are a process carried out with the cooperation of parents and children, the physician is unable to control the correct and appropriate feasibility of these methods.

5. Conclusions

The efficacy of the management methods applied in children with sleep bruxism should be evaluated by inserting a probe in sleep laboratories and with a larger number of participants. However, since our study was conducted in children, this application was limited. The findings of our study will serve as a crucial foundation for future applications of this nature. Although the use of Kinesio tape has been demonstrated to alleviate myofascial pain associated with sleep bruxism, occlusal splints are required to prevent tooth wear in cases of teeth grinding.

AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

AUTHOR CONTRIBUTIONS

KNT and GYY—conceived the ideas and led the writing. KNT, UA, MŞ, GYY, DEG, MT—collected the data. KNT and AK—analyzed the data.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The present study was conducted at the Department of Pedodontics, Faculty of Dentistry, Adıyaman University and approved by the Clinical Research Ethics Committee of our university (Number: 2022-4-2, Date: 22 September 2022). Written informed consent was obtained from the individual(s) or their legal guardians, who indicated their voluntary participation in the study and their consent for the publication of any potentially identifiable images or data included in this article.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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