Effects of Transcutaneous Occipital Nerve Stimulation and Instrument-Assisted Soft Tissue Mobilization in Chronic Migraine

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Abstract

Objective: The purpose of this study was to examine the effects of transcutaneous occipital nerve stimulation (TONS) and instrument-assisted soft tissue mobilization (IASTM) on pain, sleep, and quality of life in patients with chronic migraine.

Methods: Forty-five female patients with chronic migraine were randomly assigned to control (n = 15), IASTM (n = 15), and TONS (n = 15) groups. Neck exercises were given to all groups once per day for 5 weeks. IASTM, using a smooth metal scraping massage tool, was applied to the patients in the IASTM group twice per week for 5 weeks. Patients in the TONS group were treated with transcutaneous electrical nerve stimulation 3 times per week for 5 weeks. The outcome measures were a Numeric Pain Scale, the Headache Impact Test-6, the Pittsburgh Sleep Quality Index, and the Short Form-36.

Results: The IASTM and TONS groups had significantly lower mean Headache Impact Test-6 scores than the control group in the last measurement (F = 3.908, *P* = .028). The IASTM and TONS groups had lower mean Numeric Pain Scale scores than the control group (F = 13.861, *P* = .001). The IASTM group had a lower mean Pittsburgh Sleep Quality Index score in the last measurements than the other 2 groups (F = 6.792, *P* = .003). There was no difference between the groups in the general health perception scores obtained in the last measurements (F = 1.585, *P* = .217). In the last measurement, the IASTM and TONS groups had higher mean general health scores than the control group.

Conclusion: IASTM and TONS applications reduced head and neck pain and improved sleep and quality of life in patients with chronic migraine. Neither had superiority over the other. (J Manipulative Physiol Ther 2022;45;436-447)

Key Indexing Terms: *Exercise; Migraine Disorders; Physical Therapy Modalities*

Introduction

Migraine is the fifth leading cause of disability worldwide and is especially common in women aged under 50 years.[1,2] Neck pain, depression, and anxiety, especially that associated with migraine, are among the top 10 disabilities worldwide.[3] Migraine can be caused by many factors such as genetics, environment, hormones, some drugs, metabolism, and neck problems.[4] Migraine attacks consist of 4 stages: prodrome (eg, anxiety, depression, fatigue, and muscle tenderness), aura (temporary visual, auditory, and motor disorders), pain, and postdrome (reduction of pain).[5] Some patients are resistant to opioids, triptans, and anti-inflammatory drugs used in the treatment of migraine; excessive use of these drugs can lead to the progression of migraine.[6] Accordingly, there has been an increase in new treatment strategies in recent years.

Neck pain is a common symptom of migraine and may persist throughout the attack and can be a major contributor to migraine-related disability.[7] The high prevalence of neck pain in patients with migraine has provoked an ongoing debate about the contribution of neck muscles to the frequency of headaches and attacks.[8,9] Some authors claim that neck pain is only a symptom of a migraine attack, whereas others argue that dysfunctions in neck muscles may trigger migraine attacks and thus contribute to the transition from episodic to chronic migraine.[10,11] Eighty-eight percent of patients with primary headaches, 76% of patients with tension headaches, and 76% of patients with migraine headaches reported neck pain at any time during the attack.[11]

Myofascial trigger points in the neck and craniofacial regions may contribute to overall pain and facilitate the occurrence of migraine pain. Specifically, myofascial trigger points in the upper trapezius, sternocleidomastoid, and suboccipital muscles have been shown to lead to painful

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conditions.[12] Instrument-assisted soft tissue mobilization (IASTM) originates from the traditional Chinese therapy Gua Sha.[13] The term *Gua Sha* refers to the red spot that appears as a result of increase the blood supply to the area when an instrument is used to push or scrape the skin.[14] IASTM is short-term, simple, and practical. IASTM improves soft tissue function and ROM in injuries to soft tissues, while also reducing pain.[15] It has been stated that IASTM has positive effects on myofascial trigger points and neck pain.[16] IASTM is claimed to aid the healing process by activating fibroblasts.[17] However, studies on the mechanism of action of IASTM are generally animal studies. Therefore, the scientific basis for the mechanisms and effects of IASTM must be broadened through experimental studies in humans.

Neuromodulation, which is defined as the alteration of nerve activity through electrical stimulation or the administration of chemical agents to targeted areas of the body, is receiving increasing attention in the treatment of migraine.[18] Percutaneous occipital nerve stimulation shows promising results in the treatment of migraine and headache. However, this method is an invasive and expensive procedure.[19] Transcutaneous electrical nerve stimulation (TENS) is a noninvasive and inexpensive treatment for headaches. The United States Food and Drug Administration has approved TENS therapy for use in migraine.[20] There are studies on the supratrochlear, supraorbital, and auricular vagus nerves with TENS.[21,22] However, studies on TENS and the occipital nerve in migraine are limited.

Although alternative treatment methods are promising in migraine patients, studies on IASTM and transcutaneous occipital nerve stimulation (TONS), which are alternative methods in migraine treatment, are insufficient. This study aimed to examine the effects on migraine of 2 different treatments applied to the neck region that have become popular in recent years. We hypothesized that clinic responses to TONS and IASTM would differ in patients with chronic migraine

Methods

Patients

Forty-five female patients aged 20 to 50 years who presented to a private clinic with migraine symptoms between September 2021 and February 2022 were included in the study. The patients were randomly divided into 3 groups: the control group (n = 15), the IASTM group (n = 15), and the TONS group (n = 15). The inclusion criteria for the study were being aged 20 to 50 years, having been diagnosed as having migraine without aura using the International Classification of Headache Disorders third edition (beta) criteria, having a migraine history of at least 1 year, having a Numeric Pain Scale (NPS) (neck) value above 4, and having a Headache Impact Test-6 (HIT-6) score above 56. The exclusion criteria were receiving regular pharmacologic or nonpharmacologic treatment in the last 3 months, using a pacemaker, having epilepsy or severe psychiatric illness, undergoing surgery on the neck region, cervical disc degeneration or prolapse, and different headache diagnoses.

Randomization

The research was planned as a single-blind, randomized, and prospective study. Three different treatment options for randomization were created on a computer by a statistician and were numbered from largest to smallest by putting them in envelopes. Forty-five patients were divided into 3 groups according to the sequential randomization method. The person applying the treatment opened the envelopes in turn and applied the treatment in the envelope according to the number of the patients. The different physiotherapists performed the IASTM and TONS application and these physiotherapists were not changed during the treatment. It was not possible to blind the physiotherapist and patients. However, the outcome assessor, who evaluated clinical measurements, was unaware to the type of treatment. The Consolidated Standards of Reporting Trials (CONSORT) diagram for recruitment of participants is shown in Figure 1.

Ethical Consideration

Approval for the study was obtained from the Ethics Committee of Karatay University Faculty of Medicine Non-Invasive Clinical Research (number 2021-027). The trial was registered with ClinicalTrials.gov (NCT05372796). Oral and written information about the study was given to all patients and a voluntary consent form was signed. The study was conducted in accordance with the Ethical Principles of the Declaration of Helsinki.

Treatment

All participants performed the home exercises described in the following once per day for 5 weeks. Each exercise in the exercise program was performed with 10 repetitions.[23]

- Exercise 1: Upper cervical flexion in the supine position
- Exercise 2: Shoulder flexion in the supine position
- Exercise 3: Shoulder abduction and lateral flexion in the supine position
- Exercise 4: Neck flexion with head in the supine position
- Exercise 5: Neck flexion while seated
- Exercise 6: Neck rotation while seated
- Exercise 7: Shoulder abduction while seated
- Exercise 8: Scapula adduction while seated

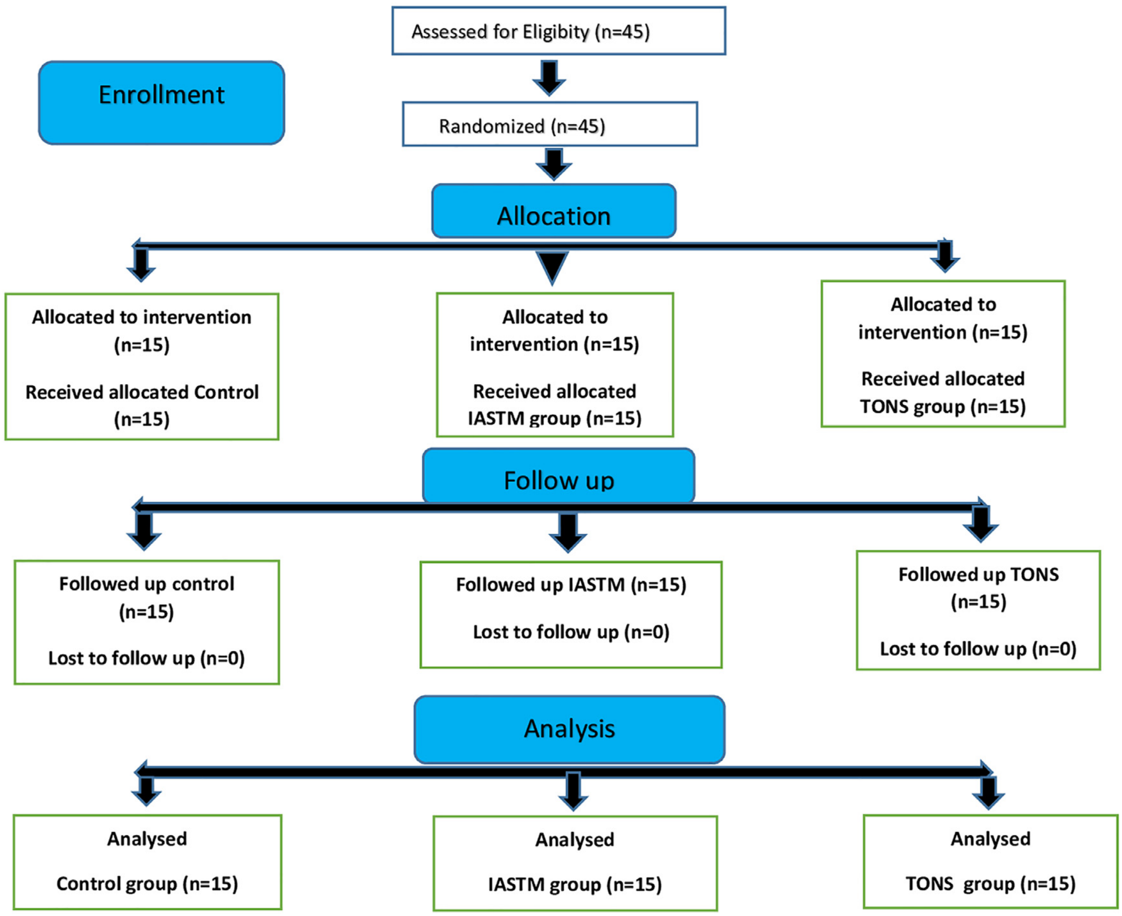

Fig 1. *Study flow.*

- Exercise 9: Neck rotation with arms raised while seated
- Exercise 10: Adduction of the scapula with arms overhead in the prone position

The patients were questioned by phone every day about whether they did the exercise, and they were asked to come to the clinic once per week to check their functional status.

IASTM was performed on the patients in the IASTM group twice per week for 5 weeks.[16] The instruments used in the treatment were smooth metal scraping massage tools.

Application to Sternocleidomastoid Muscles. The patient was placed in a sitting position**.** After the sternocleidomastoid muscle was palpated, Vaseline was applied to the area. For the superficial application, instrument number 2 was chosen and IASTM was performed from the origo-insertion and insertion-origo at 30- and 60-degree angles over the muscle skin palpated with its concave surface. Applications were performed bilaterally. To reach the deep tissues, IASTM was performed with the convex face of instrument number 3 at 30- and 60-degree angles. Then, it was aimed to relax the muscle by making small pulling applications at 90-degree angles using instrument number 4.

Application to Trapezius Muscles. The patient was placed in the prone position. After palpation of the trapezius muscle, a movement was started from the upper part of the trapezius in the origo-insertion direction, IASTM was performed at 30- and 60-degree angles with the concave face of instrument number 2. Then, the procedure was continued using the convex surface of instrument number 3 at 30- and 60-degree angles. After the regional applications, IASTM was performed in all directions using instrument number 4 at a 90-degree angle in the areas where the adhesions were intense. Then, after IASTM with the convex surface of instrument number 3 at 30- and 60-degree angles, the IASTM was performed using the concave surface of instrument number 4 in all directions. Deep friction was applied perpendicularly to the most painful points using instrument number 5.

Application to Paraspinal Muscles. The patient was placed in the prone position. After palpation of the paraspinal muscles, IASTM was performed bilaterally using the concave surface of instrument number 2 at 30- and 60-degree angles. Then, IASTM was performed in the medio-lateral and superior-inferior directions. Then, to reach deep fascial tissues, IASTM was performed in all directions using the convex surface of instrument number 3 at 30- and 60-degree angles. Using instrument number 4, applications were made in all directions at 30- and 60-degree angles in areas where facial adhesions were intense. Then, IASTM was performed using the convex surface of instrument number 3 and the concave surface of instrument number 2 at 30- and 60-degree angles, respectively.

Application to Levator Scapula Muscles. The patient was placed in the prone position. IASTM was performed using instrument number 4 along the margins of the scapula to which the levator scapula muscle was attached and along the muscle fibers. Then, using equipment number 5, deep friction was applied from the center to the outside.

In the treatment of IASTM, each technique was applied to the muscle fibers to be treated for 10 minutes with 10 to 12 repetitions.

TONS Application. Participants in the TONS group were treated with a Chattanooga direct TENS device (DJO UK Ltd, Guildford Surrey, United Kingdom) 3 times per week for 5 weeks. The patient was placed in a sitting position. Four self-adhesive 40*40-mm-sized electrodes were attached to the occipital region of the patients bilaterally, covering the occipital nerves. The current intensity was adjusted according to the patient. The current intensity started at 0 mA and was increased by 1 mA every 30 seconds, allowing the patient to tolerate the current by giving current without muscle twitching or harmful stimulation.[24] The current frequency was determined as 2/100 Hz. Square waves at 2 Hz were applied for 3 seconds followed by an automatic shift to 100 Hz for another 3 seconds.[25] The treatment time was 30 minutes.

Outcomes

Before and after the study, NPS was used to assess neck pain intensity, the headache impact test (HIT-6) was used to assess headache, the Pittsburgh Sleep Quality Index (PSQI) was used to assess sleep quality, and the Short Form-36 (SF-36) was used to assess quality of life. In addition, a 16-item form questioning clinical and demographic characteristics was completed by the participants before the study.

The NPS is a 1-dimensional scale used to determine pain intensity. The most common styles include a horizontal bar or line format. The line or bar is marked with whole numbers from 0 to 10. A value of “0” indicates no pain, and a value of “10” indicates the most severe pain.[26]

The HIT-6 was developed to measure factors contributing to headache and provides quantitative information about the impact of headache. The HIT-6 consists of 6 items: pain, social functionality, role function, vitality, cognitive function, and psychological distress. Scores ranging from 36 to 78 are obtained from the test. High scores indicate that the patient’s headache negatively affects his/her daily life.[27]

The PSQI consists of 24 questions in total. The individual answers 19 of these questions by himself/herself. The remaining 5 questions are answered by a person who lives with his/her, and if the person lives alone, he/she is evaluated for information purposes and not added as a score. The index includes 7 dimensions: subjective sleep quality, sleep latency, sleep duration, habitual sleep pattern, sleep disturbance status, use of medication to fall asleep, and daytime dysfunction. The question for each dimension scores between 0 and 3 points. The total score of 7 dimensions in total gives the sleep quality score. The total score ranges from 0 to 21. The sleep quality of people with a total score of less than 5 is “good,” and for those with more than 5, their sleep quality is interpreted as “poor.”[28]

The SF-36 quality of life index evaluates the general health status of a person. It consists of a total of 36 questions evaluating 2 basic parameters (mental and physical) and 8 subparameters (emotional function, physical function, physical role, social function, mental health, general health, vitality, and pain). Zero to 100 points can be obtained from each parameter. High scores indicate a good quality of life. [29]

Adverse Events

It was considered normal to feel tingling, numbness, and/or vibration sensations during electrical stimulation. Adverse events were considered if there were painful sensations or other uncomfortable reactions except for normal tolerability of stimulation. The patients participating in the study did not report any adverse events.

Sample Size

The sample size calculation was done using a G*power analysis software version 3.0.10 (G*Power, Franz Faul, Kiel University). It was calculated according to the previous study examining the effect of neck exercise on chronic migraine.[30] NPS scores was used to estimate the sample size. The analysis indicated that 15 participants for each group were enough to detect a large Cohen’s effect (d = 0.75) with an alpha error probability of 0.05 and a power of 80%.

Statistical Analysis

The SPSS 25 (IBM SPSS Statistics for Windows, version 25.0; IBM Corp, Armonk, NY) software package was used to evaluate the data. In the study, descriptive statistics (mean, standard error of mean, median, first quartile, third quartile, number, and percentile) are given for categorical and continuous variables. One-way analysis of variance and the Bonferroni test, one of the multiple comparison tests, were used for group comparisons. Relationships between categorical variables were analyzed using the Fisher exact test and χ^2 test.

The normality assumption was checked using the Shapiro-Wilk test. For iterative tests, the sphericity assumption was checked using the Mauchly test, and when the sphericity assumption was met, the sphericity assumed test was used. When the sphericity assumption was not met, the epsilon value was checked. The Huynh-Feldt test was used when the epsilon value was higher than 0.75 and the Greenhouse-Geisser test was used when it was lower. Mixed-design analysis of variance and the Bonferroni-Dunn test were used to make a general evaluation between repeated measurements (clinical parameters) and patient groups, and the Bonferroni-Dunn test was used to investigate the time effect. A $P < .05$ level was considered statistically significant.

Results

Demographic Data

When Table 1 is examined, the study groups show homogeneous distribution according to all demographic characteristics ($P > .05$).

NPS (Neck) Scores

NPS (neck) scores are shown in Table 2. The effect of time and groups on NPS (neck) scores was statistically significant (F = 15.276, P = .001). There was no statistically significant difference between the study groups in the first measurement (F = 2.496, P = .095), but there was a difference between the groups in NPS scores at the last measurement (F = 13.861, P = .001). The IASTM and TONS groups had lower mean NPS scores than the control group.

PSQI and HIT-6 Scores

PSQI and HIT-6 scores are presented in Table 3. The effect of time and groups on the PSQI score was statistically significant (F = 5.123, P = .010). There was no statistically significant difference between the groups in the first measurement (F = 1.076, P = .350), but there was a difference between the groups in the PSQI scores obtained in the last measurements (F = 6.792, P = .003). The IASTM group had a lower mean PSQI score than the other 2 groups.

The effect of time and groups was statistically significant for the HIT-6 score (F = 13.384, P = .001). There was no statistically significant difference between the study groups in the first measurement (F = 2.368, P = .106), but there was a significant difference between groups in HIT-6 scores at the last measurement (F = 3.908, P = .028). The IASTM and TONS groups had lower mean HIT-6 scores than the control group.

SF-36 Scores

SF-36 scores are given in Table 4. The effect of time and groups on general health perception scores was not statistically significant (F = 0.230, P = .796). There was no difference between the groups in the general health perception scores obtained in the first (F = 1.036, P = .364) and final (F = 1.585, P = .217) measurements. There was a difference in the first and last measurements in the IASTM (F = 29.554, P = .001), TONS (F = 20.524, P = .001), and control (F = 22.199, P = .001) groups. In the last measurement, the IASTM and TONS group had a higher mean general health score than the control group. There was no statistically significant difference in physical function scores between the groups in the first measurement (F = 3.326, P = .056). There was a difference in physical function scores between the groups in the last measurement (F = 13.872, P = .003). The IASTM and TONS group had a higher mean than the control group. There was no statistically significant difference in the role limitations due to physical health between the groups in the first measurement (F = 0.443, P = .645). There was a difference in the role limitations due to physical health between the groups in the last measurement (F = 4.455, P = .018). The IASTM and TONS group had a higher mean than the control group. There was no statistically significant difference in the role limitations due to emotional problems between the groups in the first measurement (F = 0.837, P = .440). There was a difference in the role limitations due to emotional problems between the groups in the last measurement (F = 4.602, P = .016). The IASTM group had a higher mean than TONS and control groups. The pain, social functioning, and energy results were similar to physical function results.

Discussion

In the current study, improvements were observed in PSQI, NPS, HIT-6, and SF-36 scores in all groups. It was determined that IASTM or TONS performed with exercise caused faster improvement in all parameters in patients with chronic migraine, but they were not superior to each other. It was thought that different treatment options such as IASTM or TONS might be beneficial in patients with chronic migraine.

Neck pain, a myofascial trigger point, and muscle tenderness are more common in patients with migraine compared with individuals without headache.[9,31,32] Also, neck pain in migraineurs potentially contributes to the chronicity of migraine.[33] Many patients report that neck pain begins with the onset of the headache accompanying the migraine attack.[10] Similarly, all of the patients with chronic migraine in the current study had neck pain.

There are studies in the literature showing that therapeutic neck exercises have positive effects on neck pain.[34,35] In addition, therapeutic neck exercises have been reported to reduce headache severity in migraine and cervicogenic headaches.[23] Similarly, NPS and HIT-6 scores were

Table 1. *Demographic Data of Participants*

		Groups								
		IASTM (n = 15) Mean ± SEM Median (IQR)		TONS (n = 15) Mean ± SEM Median (IQR)		Control (n = 15) Mean ± SEM Median (IQR)		Test Statistics	*P* Value	Effect Size
Age		41.67 ± 6.73 45 (11)		37.2 ± 8.82 36 (9)		39.87 ± 6.35 40 (10)		1.392[a]	.260	0.06
		n = 15	%	n = 15	%	n = 15	%			
Sex	Women	15	100	15	100	15	100	-	-	-
Pain type	With Aura	8	53	7	47	6	40	0.536[b]	.765	0.10
Pain severity	Mild	1	7	3	20	0	0	5.131[b]	.274	0.23
	Moderate	10	67	6	40	10	67			
	Severe	4	27	6	40	5	33			
Sensitivity to sound	Yes	13	87	12	80	8	53	4.773[b]	.092	0.32
Sensitivity to light	Yes	13	87	12	80	9	60	3.128[b]	.209	0.26
Nausea	Yes	5	33	8	53	4	27	2.458[b]	.293	0.23
Vomiting	Yes	1	7	3	20	2	13	1.154[b]	.562	0.16
Pain with activity	Yes	13	87	11	73	10	67	1.684[b]	.431	0.19
Olfactory sensitivity	Yes	10	67	6	40	3	20	5.550[b]	.051	0.36
Dizziness	Yes	7	47	3	20	5	33	2.400[b]	.301	0.23
Tinnitus	Yes	6	40	2	13	2	13	4.114[b]	.128	0.30
Side of neck pain	One sided	1	7	4	27	0	0	5.850[b]	.054	0.36
	Double sided	14	93	11	73	15	100			
Neck pain	Yes	15	100	15	100	15	100	-	-	-
Neck spasm	Yes	15	100	15	100	15	100	-	-	-
Is massage positive?	Yes	15	100	15	100	15	100	-	-	-

IASTM, instrument-assisted soft tissue mobilization; *IQR*, interquartile range; *SEM*, standard error mean; *TONS*, transcutaneous occipital nerve stimulation.
[a] Analysis of variance.
[b] χ^2 test.

decreased in all groups in the current study. In a recent study, it was emphasized that neck exercises performed with cervicogenic headache should cover the shoulder, neck, and scapular regions.[23] Similarly, neck exercises were applied to the shoulder girdle and neck region in the current study.

IASTM is a manual therapy method performed using stainless steel instruments of various sizes. IASTM increases blood circulation, fibroblastic activity, and reduces adhesion and scar tissue in the area where it is applied.[36] It has been stated that IASTM has beneficial effects in painful conditions related to the neck, waist, shoulder, elbow, hip, knee, and ankle.[37] Studies examining the effect of IASTM on head and neck pain are limited. Mylonas et al[38] used IASTM and neuromuscular exercise on 20 individuals with mechanical neck pain and showed that IASTM and exercise positively affected the functional status of patients with neck pain. In another study, IASTM and massage were performed on 20 people with pain in the upper trapezius muscle, and at the end of the study, it was

Table 2. *NPS (Neck) Scores*

		Groups			*TS*[a] *(Group)*			*TS*[b] *(Group × Time)*		
		IASTM (n = 15) Mean ± SD Median (IQR)	TONS (n = 15) Mean ± SD Median (IQR)	Control (n = 15) Mean ± SD Median (IQR)	TS	*P* Value	ES	TS	*P* Value	ES
NPS	First	6.40 ± 0.82 6 (1)	7.20 ± 1.26 7 (2)	6.47 ± 1.12 6 (2)	2.496	.095	0.106	15.276	.001	0.421
	Last	2.27 ± 0.79 2 (1)	2.53 ± 0.99 3 (1)	4.27 ± 1.48 4 (2)	13.861	.001	0.398			
TI[c] *(time)*	TI	154.940	197.505	43.894						
	P value	.001	.001	.001						
	Effect size	0.78	0.82	0.51						

IASTM, instrument-assisted soft tissue mobilization; ES, effect size ; TS, Test statistics *IQR*, interquartile range; *NPS*, Numeric Pain Scale; ; SD, Standard deviation; *TONS*, transcutaneous occipital nerve stimulation; *TI*, test statistics.
[a] Between groups.
[b] Comparison of the first and last score differences between groups.
[c] In groups.

Table 3. *PSQI and HIT-6 Scores*

		Groups			*TS*[a] *(Group)*			*TS*[b] *(Group × Time)*		
		IASTM (n = 15) Mean ± SEM Median (IQR)	TONS (n = 15) Mean ± SEM Median (IQR)	Control (n = 15) Mean ± SEM Median (IQR)	TS	*P* Value	Effect size	TS	*P* Value	Effect size
PSQI	First	10.93 ± 2.18 11 (3)	11.00 ± 1.46 11 (2)	11.87 ± 2.100 12 (3)	1.076	.350	0.049	5.123	.010	0.19
	Last	5.13 ± 1.88 6 (2)	7.6 ± 2.32 8 (5)	8.4 ± 3.20 9 (6)	6.792	.003	0.244			
TI[c] *(time)*	TI	92.251	31.701	32.956						
	P value	.001	.001	.001						
	Effect size	0.68	0.43	0.44						
HIT-6	First	63.20 ± 6.08 66 (12)	63.67 ± 5.55 66 (8)	59.73 ± 4.464 60 (4)	2.368	.106	0.101	13.384	.001	0.38
	Last	48.27 ± 3.69 48 (6)	48.67 ± 4.76 48 (6)	52.40 ± 4.852 52 (10)	3.908	.028	0.157			
TI[c] *(time)*	TI	153.667	155.042	37.057						
	P value	.001	.001	.001						
	Effect size	0.78	0.78	0.46						

HIT-6, Headache Impact Test-6; *IASTM*, instrument-assisted soft tissue mobilization; *IQR*, interquartile range; *PSQI*, Pittsburgh Sleep Quality Index; *SEM*, standart error mean; *TONS*, transcutaneous occipital nerve stimulation; *TS*, test statistics.
[a] Between groups.
[b] Comparison of the first and last score differences between groups.
[c] In groups.

Table 4. *SF-36 Scores*

		Groups			*TS*[a] *(Group)*			*TS*[b] *(Group × Time)*		
		IASTM (n = 15) Mean ± SEM Median (IQR)	TONS (n = 15) Mean ± SEM Median (IQR)	Control (n = 15) Mean ± SEM Median (IQR)	TS	*P* value	Effect size	TS	*P* value	Effect size
Physical function	First	53.33 ± 19.97 50 (40)	69 ± 17.94 65 (35)	51.67 ± 22.73 50 (30)	3.325	.056	0.13	3.955	.027	0.15
	Last	89.67 ± 5.16 90 (10)	89.00 ± 7.12 90 (10)	71 ± 16.92 70 (20)	13.872	.001	0.39			
TI[c] *(time)*	TI	56.321	17.065	15.947						
	P value	.001	.001	.001						
	Effect size	0.57	0.28	0.27						
Role limitations due to physical health	First	41.67 ± 24.39 25 (25)	50.00 ± 29.88 50 (50)	41.67 ± 29.37 25 (50)	0.443	.645	0.02	2.906	.066	0.12
	Last	75.00 ± 16.36 75 (0)	76.67 ± 24.02 75 (50)	56.67 ± 19.97 50 (25)	4.455	.018	0.17			
TI[c] *(time)*	TI	37.500	24.000	7.594						
	P value	.001	.001	.009						
	Effect size	0.47	0.36	0.15						
Role limitations due to emotional problems	First	28.86 ± 27.76 33 (67)	28.87 ± 24.77 33 (33)	39.97 ± 28.71 33 (33)	0.837	.440	0.03	5.231	.009	0.19
	Last	68.83 ± 15.27 67 (0)	48.86 ± 27.79 33 (33)	48.84 ± 17.19 33 (33)	4.602	.016	0.18			
TI[c] *(time)*	TI	33.651	8.413	1.658						
	P value	.001	.006	.205						
	Effect size	0.44	0.16	0.03						
Energy	First	40.67 ± 13.61 45 (20)	39.67 ± 16.08 40 (20)	40.00 ± 10.17 45 (15)	0.021	.979	0.001	3.596	.036	0.14
	Last	75.00 ± 9.25 75 (15)	61.33 ± 16.74 65 (20)	58 ± 14.85 60 (25)	6.224	.004	0.22			
TI[c] *(time)*	TI	57.717	22.986	15.864						
	P value	.001	.001	.001						
	Effect size	0.57	0.35	0.27						
Emotional well-being	First	45.07 ± 13.30 48 (12)	53.33 ± 18.24 56 (20)	46.27 ± 7.28 48 (16)	1.595	.215	0.07	0.529	.593	0.02
	Last	47.73 ± 7.63 48 (8)	58.13 ± 16.20 56 (28)	46.40 ± 9.77 48 (12)	4.461	.018	0.17			

(*continued*)

Table 4. (*Continued*)

		Groups			*TS*[a] *(Group)*			*TS*[b] *(Group × Time)*		
		IASTM (n = 15) Mean ± SEM Median (IQR)	TONS (n = 15) Mean ± SEM Median (IQR)	Control (n = 15) Mean ± SEM Median (IQR)	TS	*P* value	Effect size	TS	*P* value	Effect size
TI[c] *(time)*	TI	0.69	2.235	0.002						
	P value	.411	.142	.967						
	Effect size	0.01	0.05	0.001						
Social functioning	First	39.83 ± 13.74 38 (25)	48 ± 16.80 50 (13)	37.33 ± 7.81 38 (5)	2.631	.084	0.11	9.039	.001	0.30
	Last	83.33 ± 9.04 88 (13)	74.17 ± 15.28 75 (25)	54.33 ± 17.07 50 (38)	16.291	.001	0.43			
TI[c] *(time)*	TI	94.438	34.171	14.423						
	P value	.001	.001	.001						
	Effect size	0.69	0.44	0.25						
Pain	First	39.17 ± 8.64 35 (13)	40.67 ± 15.96 38 (23)	37.67 ± 11.07 35 (20)	0.224	.800	0.01	7.317	.002	0.25
	Last	83.33 ± 8.38 80 (13)	75.83 ± 15.57 78 (10)	57.83 ± 18.02 55 (33)	12.120	.001	0.36			
TI[c] *(time)*	TI	97.092	61.554	20.242						
	P value	.001	.001	.001						
	Effect size	0.69	0.59	0.32						
General health	First	44.67 ± 15.52 45 (15)	47.67 ± 12.79 45 (20)	41.00 ± 8.90 40 (10)	1.036	.364	0.04	0.230	.796	0.01
	Last	64.67 ± 10.08 65 (10)	64.33 ± 9.97 65 (10)	58.33 ± 12.63 60 (20)	1.585	.217	0.07			
TI[c] *(time)*	TI	29.554	20.524	22.199						
	P value	.001	.001	.001						
	Effect size	0.41	0.32	0.34						

IASTM, instrument-assisted soft tissue mobilization; *IQR*, interquartile range; *SEM*, standard error mean; *SF-36*, Short Form-36; *TONS*, transcutaneous occipital nerve stimulation; *TS*, test statistics.
[a] Between groups.
[b] Comparison of the first and last score differences between groups.
[c] In groups.

determined that the pain in the upper trapezius area decreased and functionality increased.[16] In a pilot study, 10 college students with cervicogenic headache underwent 3 sessions of IASTM every day for 2 weeks and it was reported that IASTM could be effective in the treatment of headache.[39] In another study, 30 patients with tension-type headache were divided into conventional physical therapy and IASTM groups. Both groups were treated 3 days per week for 4 weeks. As a result, it was stated that IASTM reduced pain and increased functional capacity compared with traditional physical therapy.[40] Similarly, in the current study, NPS and HIT-6 scores were decreased more rapidly in the IASTM group compared with the control group.

TENS is a method in which mild electrical currents are used to relieve pain. TENS can be subdivided into 3 types, the most common (in clinical practice) being conventional

TENS (low intensity/high frequency), acupuncture-like TENS (high intensity/low frequency), and intense TENS (high intensity/high frequency).[41] The mechanism of action of TENS is controversial. Some studies indicate that low-frequency TENS blocks μ-opioid, γ-aminobutyric acid (GABA), and serotonin receptors, whereas others indicate that high-frequency TENS increases endorphin and enkephalin levels.[42,43] Han[25] showed that co-administration of low-frequency and high-frequency TENS maximized enkephalin, endorphin, endomorphin, and dynorphin levels. Similarly, we used 2/100-Hz TENS in the current study. There are studies in the literature showing the positive effects of TENS on headache. Bono et al[44] applied occipital TENS 3 times per day for 2 weeks to 160 individuals with chronic migraine and tension-type headache, and they found that continuous allodynia was reduced in the patients. Another study compared the efficacy of neurofeedback and TENS in the treatment of primary headaches. As a result, it was concluded that TENS was an effective treatment method for preventing primary headaches.[45] Liu et al[24] investigated the effect of TONS at different frequencies on migraine and they achieved promising results in the treatment of migraine. Similarly, in the current study, TONS application caused a more decrease in NPS and HIT-6 scores compared with the control group.

Insomnia is a common symptom in patients with chronic migraine.[46] The positive correlation between migraine symptoms and poor sleep in migraine patients was demonstrated by PSQI.[47] Similarly, the individuals participating in the current study had high initial PSQI scores, indicating poor sleep quality. The relationship between migraine and sleep is complex. Conditions such as parasomnia, narcolepsy, snoring, and sleep apnea are more common in patients with migraine than in healthy individuals.[48] Recent biochemical and functional imaging studies have identified central nervous system structures and neurotransmitters that are involved in the pathophysiology of migraine and are also important for the regulation of normal sleep.[49] Current evidence indicates that the diencephalic and brainstem regions are the main anatomic structures involved in the pathogenesis of migraine and the regulation of the sleep-wake cycle and that orexins, melatonin, serotonin, dopamine, and adenosine are essential neurotransmitters.[50] It has been reported that the severity of pain in migraine also impairs sleep quality. The amount of sleep decreases with symptoms of central sensitization such as allodynia and precranial tenderness seen in migraine.[51] Decreased headache causes an increase in sleep time, and increasing headache causes a decrease in sleep time.[52] In the current study, it was observed that sleep quality increased with the decrease in pain intensity.

Migraine reduces quality of life by negatively affecting work and social life, especially in middle-aged women.[53] Migraine also negatively affects quality of life by causing anxiety and depression. [54] In a recent review, it was stated that nonpharmacologic treatment methods improved the quality of life in patients with migraine.[55] As a result of a pilot study using the soft tissue technique in patients with migraine, it was determined that the severity of pain decreased and their quality of life increased.[56] Manual therapy and neck exercises have been shown to positively improve the quality of life in patients with migraine.[57] In agreement, the quality of life of the participants in the current study increased positively.

Limitations

First, long-term follow-up of the patients was not performed. Therefore, the long-term effects of the treatments performed were not investigated. In addition, the blood levels of neurotransmitters, which play an important role in migraine, could not be measured. We think that the effects of alternative treatment methods on migraine will be clarified with comprehensive studies in the future.

Conclusion

Both IASTM and TONS reduced head and neck pain and improved sleep and quality of life in patients with chronic migraine, but neither was superior to the other.

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

Contributorship Information

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

Practical Applications

- As a result of the study, positive effects of transcutaneous occipital nerve stimulation and instrument-assisted soft tissue mobilization applications were observed in the treatment of migraine.
- It was thought that both applications were safe and effective in the treatment of migraine and could be added to the treatment program.

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