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Acute Effect of Kinesiological Tape on Pain and Mechanical Properties of the Trapezius Muscle in Neck Pain Due to Smart Phone Addiction

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ABSTRACT

This study aimed to assess the short-term effects of inhibitory kinesiologic tape (KT) and sham tape on neck pain and muscle tone in individuals with smartphone addiction. Forty-two healthy participants were randomized to receive either KT or sham tape application to their upper trapezius muscle (UTM). Smartphone addiction was assessed using the Smartphone Addiction Scale (SAS), and pain severity was measured using the Visual Analogue Scale (VAS). Muscle tone and stiffness were evaluated using a myotonometer. No significant differences were found in pain or muscle mechanical properties between the groups after treatment. However, KT recipients had significantly higher tone and stiffness in their left trapezius muscle compared to their right trapezius muscle ($p < 0.05$). Additionally, right trapezius stiffness was significantly higher in participants with SAS scores of 100 points or more compared to those with SAS scores below 100 points ($p < 0.05$). Finally, left trapezius elasticity increased significantly in participants with SAS scores of 100 points or more ($p < 0.05$). Overall, the study findings suggest that short-term application of KT to the UTM may reduce neck pain in individuals with smartphone addiction.

Keywords: Kinesiotherapy, mobile phone, neck pain

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Akıllı Telefon Bağımlılığına Bağlı Boyun Ağrısında Kinesyolojik Bandın Ağrı ve Trapez Kasının Mekanik Özellikleri Üzerine Akut Etkisi

ÖZ

Akıllı telefon bağımlılığı olan bireylerde üst trapezius kasına inhibisyonlu kinezyoloji bandı (KT) ve sahte bant uygulamasının boyun ağrısı ve kas tonusu üzerindeki kısa süreli etkilerini değerlendirmeyi amaçlayan bir çalışma yapıldı. Çalışmaya 42 sağlıklı katılımcı katıldı ve rastgele olarak KT veya sahte bant uygulamasına alındı. Akıllı telefon bağımlılığı, Akıllı Telefon Bağımlılık Ölçeği (ATBÖ) ile değerlendirildi ve ağrı şiddeti Görsel Analog Skalası(GAS) ile ölçüldü. Kas tonusu ve sertliği, bir miyotonometre ile değerlendirildi. Tedavi sonrası gruplar arasında ağrı veya kas mekanik özelliklerinde anlamlı bir fark bulunmadı. Ancak, KT uygulaması alan katılımcıların sol trapezius kasında tonu ve sertliği, sağ trapezius kasına göre istatistiksel olarak anlamlı derecede yüksek bulundu ($p < 0,05$). Ek olarak, sağ trapezius sertliği, ATBÖ puanı 100 veya daha fazla olan katılımcılarda, puanı 100'ün altında olan katılımcılara göre istatistiksel olarak anlamlı derecede yüksek bulundu ($p < 0,05$). Son olarak, ATBÖ puanı 100 veya daha fazla olan katılımcılarda sol trapezius elastikiyeti istatistiksel olarak anlamlı derecede arttı ($p < 0.05$). Çalışma bulguları genel olarak, üst trapezius kasına kısa süreli KT uygulamasının akıllı telefon bağımlılığı olan bireylerde boyun ağrısını azaltabileceğini düşündürmektedir.

Anahtar Kelimeler: Kinezyotape, Cep telefonu, Boyun ağrısı

1 Introduction

Smartphones have become increasingly popular due to their touchscreen interface, Internet access, social networking, and gaming applications, as well as their ability to handle various tasks. They have even replaced other devices like cameras and laptops [1,2]. However, excessive smartphone use can lead to addiction and cause physical, psychological, and social harm [3,4]. Neck pain is a common musculoskeletal complaint among smartphone users, with prevalence rates ranging from 17.3% to 67.8% [5]. This is because smartphone use often leads to head and neck flexion, altering muscle activity and increasing stress on the cervical spine. The upper trapezius and neck extensor muscles become more active, while the thoracic extensors and lower trapezius muscles are less active [6,7]. A flexes posture leads to alteration in muscle activity and increased stress on the cervical spine. There is increased activity of the neck extensor muscles and upper trapezius [8].

Kinesio Taping (KT) is a method used in prevention and rehabilitation. It is an elastic-cotton adhesive tape that can be stretched by 130-140% of its original length, mimicking the skin's properties. The exact mechanism of how KT works is not fully understood, but it is believed to involve cutaneous mechanoreceptors providing feedback and mechanical restraint, as well as inhibitory and excitatory nociceptive stimuli. Studies have shown that KT can decrease pain, muscular spasms, and increase range of motion (ROM) [9-13].

Studies have shown that kinesio tape can be effective in reducing pain, muscular spasms, and increasing range of motion in a variety of conditions, including neck pain. For example, a study Lee et al. (2017) found that kinesio tape was significantly more effective than sham tape in reducing neck pain and improving range of motion in patients with chronic neck pain [14].

This study aims to investigate the acute effects of applying kinesiology inhibitor tape to the UTM, compared to a sham tape, on neck pain and muscle mechanical properties in individuals with smartphone

addiction. The researchers recognize the need to explore treatment methods for the problems caused by smartphone addiction, as there is a lack of official diagnostic criteria for this condition.

2 Methodology

2.1 Study design

This study included sedentary, healthy participants aged 18-30 years. Individuals with a BMI over 30 kg/m2 and a history of neck and upper extremity injuries or limited range of motion in the past six months were excluded. Participants were instructed not to consume alcohol, caffeine, cigarettes, or medications 24 hours before the study. All participants were informed about the study and provided consent. Ethical approval was obtained from the Ethics Committee for Science, Social and Non-Invasive Health Sciences of Istanbul Okan University (23.02.2022/150).

A sample size calculation was performed using the G*Power version 3.1 software. In a previous study, the effects of kinesiology tapes on pain were evaluated and it was found that for an effect size of 0.469, there should be 20 observations in each group with a statistical power level of 80.6% and a significance level of 5%. Consistent with these results, this study aimed to recruit at least 40 participants in two groups. To account for potential data loss, an additional 10% of the calculated sample was added, for a total of 42 participants [15].

An online randomization tool called “GraphPad” was used to assign participants to groups.

2.2 Outcome measures

Demographic data, smartphone addiction levels, pain severity, and muscle mechanical properties of the participants were assessed using the following instruments:

Demographics: Age, gender, weight, height, BMI, daily smartphone usage time, and duration of owning a smartphone were recorded.

Smartphone Addiction Scale (SAS): This 33-item scale measures smartphone addiction levels. Participants rated their responses on a six-point Likert scale, with higher scores indicating a greater risk of smartphone addiction [16]. The Turkish version of the SAS has good reliability (Cronbach's alpha = 0.94) [17].

Assessment of Pain Severity: Participants' neck pain was evaluated using the Visual Analog Scale (VAS), which is a 10-cm horizontal line ranging from "no pain" to "severe pain." Participants indicated their pain level on the scale, with scores ranging from 0 to 10 [18].

Assessment of Mechanical Properties of UTM: The MyotonPRO device was used to measure the mechanical properties of the UTM bilaterally at rest [19]. The device applies downward pressure, and the following parameters were recorded:

Oscillation frequency (muscle tone, Hz): A measure of the muscle's stiffness.

Dynamic stiffness (resistance to external forces, N/m): A measure of the muscle's resistance to stretching.

Logarithmic decrement (mechanical energy consumption of the tissue in an oscillation cycle): A measure of the muscle's energy absorption.

Stress relaxation time (ms): The time it takes for the muscle to relax after a contraction.

Creep (the ratio of deformation and relaxation time): A measure of the muscle's compliance.

These parameters provide insights into the biomechanical and viscoelastic properties of the muscle. The MyotonPRO device has been shown to be reliable and valid in previous studies. The measurements were performed by an experienced physical therapist while ensuring the device's stability and proper positioning [20].

2.3 Treatment

Kinesiology Tape Application

Kinesiology tape was applied to the UTM of the kinesiology tape group (KTG) using the I-strip inhibition method, which is a muscle technique that aims to inhibit the UTM. The tape was applied in reverse lateral flexion and ipsilateral rotation of the cervical spine.

The sham group (SG) received an I-strip kinesiology tape application to the UTM without any specific positioning.

2.4 Statistical Analysis

The statistical software SPSS 25 (IBM Corp., Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.) was used for data analysis.

Descriptive statistics were calculated for both categorical and continuous variables, including mean, standard deviation, median, minimum, maximum, number, and percentile. Homogeneity of variance was assessed using the Levene test, and normality was assessed using the Shapiro-Wilk test.

To assess differences between the two groups, an independent-samples t-test was used when the parametric test requirements were met, and a Mann-Whitney U test was used when they were not met. Relationships between categorical variables were analyzed using the Fisher's exact and chi-square tests. A p-value of <0.05 was considered statistically significant.

3 Results and Discussion

Table 1 shows the demographic characteristics of the participants. A homogeneous distribution of the groups can be seen ($p>0.05$).

Table 1: *Demographic characteristics of the participants*

		Group				Test st.	p	EB
		KTG (n=21)		SG (n=21)				
		Mean	**SD**	**Mean**	**SD**			
Age (years)		21.86	2.89	21.10	2.07	0.983 ‡	0.332	0.155
Height (cm)		168.05	8.69	168.10	8.17	-0.018 ‡	0.985	0.003
Weight (kg)		58.71	13.45	60.57	13.26	-0.451 ‡	0.655	0.071
Duration of owning a smartphone		10.00	2.828	9.67	2.763	0.386 ‡	0.701	0.061
Daily smartphone usage time (hours)		4.86	1.652	5.67	2.869	-1.120 ‡	0.269	0.177
Smartphone Addiction score		104.43	20.71	99.95	17.65	0.754 ‡	0.455	0.119
		N	**%**	**n**	**%**			
Gender	Female	16	76	17	81	0.141 †	0.707	0.058
	Male	5	24	4	19			
Dominant Extremity	Right	18	86	19	90	5.027 †	0.081	0.346
	Left	3	14	0	0			
	Right/left	0	0	2	10			

*p<0,05; †: Chi-Square Test (χ^2); ‡: Independent sample t Test (*t*); Summary statistics were given as *mean* ± *standard* for numerical data and as *Number (Percentage)* for categorical data. KTG: Kinesiology Tape group, SG: Sham Group

Both the KTG group and the SG showed a statistically significant decrease in pain severity after treatment compared to before treatment ($p<0.05$). However, there was no significant difference between the two groups ($p>0.05$). There were also no statistically significant differences in the mechanical properties of the UTM after treatment ($p>0.05$, Table 2).

Table 2: *Participants' Pre- and Post-Treatment Pain and Mechanical Properties of UTM*

		Group				*Tİ† (Group)*			*Tİ& (Group x Time)*		
		KTG (n=21)		SG (n=21)		Test sta.	p	EB	Test Sta.	p	EB
		Mean	SD	Mean	SD						
VAS	Pretest	4.86	2.632	3.38	2.439	1.885	0.067	0.298	-0.244	0.808	0.039
	Posttest	3.86	2.575	2.48	1.537	**2.111**	**0.041**	**0.334**			
Tİ¥ (Time)	Test sta.	**3.416**		**3.516**							
	P	**0.003**		**0.002**							
	EB	**0.540**		**0.556**							
Muscle Tone / Oscillation Frequency Hz(right)	Pretest	16.77	1.427	16.86	2.379	-0.142	0.888	0.022	-0.953	0.346	0.151
	Posttest	16.88	1.022	23.91	33.041	0.022	0.982	0.003			
Tİ¥ (Time)	Test sta.	-0.404		-0.969							
	P	0.690		0.344							
	EB	0.064		0.153							
Muscle Tone / Oscillation Frequency Hz(left)	Pretest	17.06	1.560	17.05	1.867	-0.103	0.918	0.016	0.411	0.683	0.065
	Posttest	17.64	1.918	17.44	1.703	0.226	0.823	0.036			
Tİ¥ (Time)	Test sta.	-1.632		-1.272							
	P	0.118		0.218							
	EB	0.258		0.201							
Stiffness N/m (right)	Pretest	285.52	36.751	287.48	78.501	0.550	0.585	0.087	0.619	0.539	0.098
	Posttest	289.90	25.219	284.05	43.345	0.048	0.962	0.008			
Tİ¥ (Time)	Test sta.	-0.659		0.320							
	P	0.517		0.752							
	EB	0.104		0.051							
Stiffness N/m(left)	Pretest	302.90	51.319	298.86	64.167	0.712	0.481	0.113	0.073	0.942	0.012
	Posttest	315.33	56.796	310.19	50.009	-0.097	0.923	0.015			
Tİ¥ (Time)	Test sta.	-1.269		-0.999							
	P	0.219		0.330							
	EB	0.201		0.158							
Elasticity / Logarithmic Decrement (right)	Pretest	0.95	0.149	0.93	0.099	0.874	0.387	0.138	1.000	0.323	0.158
	Posttest	5.63	21.395	0.94	0.136	0.117	0.907	0.018			
Tİ¥ (Time)	Test sta.	-1.003		-0.392							
	P	0.328		0.699							
	EB	0.159		0.062							
Elasticity / Logarithmic Decrement (left)	Pretest	0.95	0.107	0.95	0.145	-0.974	0.336	0.154	-0.958	0.344	0,151
	Posttest	0.94	0.103	0.96	0.129	0.366	0.716	0.058			
Tİ¥ (Time)	Test sta.	0.425		-0.882							
	P	0.675		0.388							
	EB	0.067		0.140							
Relaxation Time (ms) (right)	Pretest	17.41	2.008	16.85	2.992	0.535	0.595	0.085	-0.93	0.358	0.147
	Posttest	17.07	1.362	17.05	2.027	0.311	0.757	0.049			
Tİ¥ (Time)	Test sta.	0.971		-0.428							
	P	0.343		0.673							
	EB	0.154		0.068							
Relaxation Time (ms) (left)	Pretest	16.64	2.367	16.71	2.694	1.005	0.321	0.159	0.12	0.905	0.019
	Posttest	16.12	2.890	16.10	2.173	-0.582	0.564	0.092			
Tİ¥ (Time)	Test sta.	0.844		1.384							
	p	0.409		0.182							
	EB	0.133		0.219							
Ratio of relaxation time over deformation time / Creep (right)	Pretest	1.05	0.122	1.01	0.161	0.036	0.972	0.006	-0.642	0.525	0.102
	Posttest	1.03	0.081	1.01	0.110	0.018	0.986	0.003			
Tİ¥ (Time)	Test sta.	1.051		0.058							
	p	0.306		0.955							
	EB	0.166		0.009							
Ratio of relaxation time over deformation time / Creep (left)	Pretest	1.01	0.135	1.00	0.155	0.591	0.558	0.093	-0.011	0.991	0.002
	Posttest	0.98	0.160	0.97	0.115	0.110	0.913	0.017			
Tİ¥ (Time)	Test sta.	0.829		1.154							
	p	0.417		0.262							
	EB	0.131		0.182							

Tİ: Test statistics, *t*: Independent Sample t-Test, *t**: Dependent Sample t Test, †B, ¥Between-groups comparison, & Comparison of the first and last score differences between groups, summary statistics were given as *mean ± standard deviation*. KTG: Kinesiology Tape group, SG: Sham Group

Since the Smartphone Addiction Scale (SAS) has no cut-off value, participants in this study were divided into two groups: those with an SAS score below 100 and those with an SAS score of 100 or more.

Assessment of muscle mechanical properties before treatment revealed that participants with an SAS score of 100 or more had significantly higher stiffness in the right trapezius muscle and significantly increased elasticity in the left trapezius muscle than those with an SAS score below 100 ($p<0.05$ for both comparisons). Additionally, participants with an SAS score of 100 or more had significantly decreased deformation in the right trapezius muscle and significantly decreased relaxation time in both trapezius muscles ($p<0.05$ for all comparisons, Table 3).

Table 3: *Groups' Pre-Treatment Pain and Mechanical Properties of UTM by Smartphone Addiction Levels*

	(SAS>100) (n=19)		**(SAS<100) (n=23)**		Test sta.	p	EB
	Mean	**SD**	**Mean**	**SD**			
VAS	3.47	2.14	4.65	2.89	-1.474	0.148	0.233
Muscle Tone/ Oscillation Frequency (Hz) (right)	17.29	2.31	16.42	1.50	1.464	0.151	0.232
Muscle Tone / Oscillation Frequency (Hz) (left)	17.36	2.01	16.80	1.39	1.067	0.293	0.169
Stiffness (N/m) (right)	303.00	79.04	272.87	35.93	**2.938**	**0.009**	**0.465**
Stiffness (N/m) (left)	310.42	72.74	293.00	40.90	0.978	0.334	0.155
Elasticity / Logarithmic Decrement (right)	0.94	0.09	0.93	0.15	0.409	0.684	0.065
Elasticity / Logarithmic Decrement (left)	0.98	0.13	0.92	0.12	**3.610**	**0.015**	**0.571**
Relaxation Time (ms) (right)	16.46	2.88	17.69	2.11	-1.598	0.118	0.253
Relaxation Time (ms) (left)	16.49	3.04	16.83	2.02	-0.435	0.666	0.069
Ratio of relaxation time over deformation time / Creep (right)	0.98	0.16	1.07	0.12	**-2.067**	**0.045**	**0.327**
Ratio of relaxation time over deformation time / Creep (Left)	0.99	0.17	1.01	0.11	-0.447	0.657	0.071

t: Independent Sample t-Test, Summary statistics were given as *mean* ± *standard value* for numerical data.

This study found that pain was significantly reduced in both the kinesiology tape group (KTG) and the sham group, suggesting that the short-term use of kinesiology tape does not have an effect on muscle mechanical properties.

People who use smartphones often keep their heads in a flexed position for long periods of time. One study found that keeping the neck in 60° flexion is equivalent to carrying a 60-pound weight on the neck [21]. In addition, studies have shown that prolonged smartphone use can lead to decreased neck range of motion, pain, sensitivity, increased muscle activation, and proprioceptive impairment [22-24].

Similar to these findings, this study found that muscle stiffness, deformation, elasticity, and relaxation time were increased in individuals with a Smartphone Addiction Scale (SAS) score of 100 or more. Additionally, all participants experienced neck pain. This result suggests that smartphone addiction reduces muscle elasticity.

The study also found that acute kinesiology tape application reduced neck pain in both the KTG and sham group. This could be due to the placebo effect of kinesiology tape application.

While some studies on neck pain have found that kinesiology tape application has positive effects [11,25], other studies have found that it has no effect [26]. These conflicting results have raised questions about the true effectiveness of kinesiology tape.

To test the actual effects of kinesiology tape, researchers have conducted studies in which participants are blindfolded and not informed of the main purpose of the experiment, negating the possible placebo effects of kinesiology tape. For example, Cai et al. (2016) successfully deceived a group of participants who were unaware of the possible effects of kinesiology tape. At the end of the study, they reported that the use of kinesiology tape did not increase muscle activity or strength [27]. Two other studies [28,29] with a similar study design showed that kinesiology tape did not improve muscle strength or functional performance in either sedentary adults or sub-elite athletes.

Placebo theorists have attempted to explain the placebo effect of kinesiology tape using the positive expectancy theory, which states that a placebo-prone person is more likely to experience a placebo effect if they have positive beliefs about the treatment.

There are few studies investigating the effect of kinesiology tape on muscle tone. One such study by Ptaszkowski et al. (2015) found that the application of kinesiology tape to the UTM and post-isometric muscle relaxation had no effect on the resting bioelectrical activity of the muscle [13]. However, the application of kinesiology tape was found to be more effective in relieving pain than the other applications.

While previous studies have assessed muscle activity with superficial electromyography (EMG), this study assessed muscle mechanical properties with the Myoton Pro device. As a result of this study, no significant changes were observed in muscle mechanical properties.

At the end of the study, no difference was found in the muscle mechanical properties of the trapezius muscle in either group. This could be due to the short-term application of kinesiology tape. One study found that 24-hour application of kinesiology tape to the neck had a positive effect on pain and range of motion, but this effect was not related to the trapezius muscle. It is important to note that the application of kinesiology tape can cause different responses in different muscles.

Additionally, the results of this study cannot be generalized to individuals outside of the 18-30 year old age range. Another limitation of the study was the short duration of treatment and the lack of long-term follow-up of participants.

4 Conclusion

As a result of the study, it was found that short-term application of KT to the UTM in the smartphone addiction reduced pain, but this effect was also observed in the sham group. Future studies may examine the effects of using KT on different muscle groups and at different times in the neck.

5 Declarations

5.1 Study Limitations

Short duration of treatment and the lack of long-term follow-up of participants.

5.2 Acknowledgements

There is no person or institution contributing to this research other than the authors.

5.3 Funding source

No financial support was received for this research.

5.4 Authors' Contributions

Corresponding Author Emine ATICI: Developing ideas or hypotheses for the research and/or article, planning the materials and methods to reach the results, taking responsibility for the experiments, organizing and reporting the data, taking responsibility for the explanation and presentation of the results.

2. Author Mustafa Savaş TORLAK: Taking responsibility for the explanation and presentation of the results, taking responsibility for the literature review during the research, taking responsibility for the creation of the entire manuscript or the main part, reworking not only in terms of spelling and grammar but also intellectual content or other contributions

5.5 Competing Interests

There is no conflict of interest in this study.

6 Human and Animal Related Study

6.1 Ethical Approval

Ethical approval of the study was obtained from the Istanbul Okan University Science, Social and Non-Invasive Health Sciences Research Ethics Committee (23.02.2022/150)

6.2 Informed Consent

All participants were informed about the study and provided consent.

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