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Original Article

Can the effects of muscle techniques in kinesiotaping be demonstrated objectively in female healthy individuals? An electrophysiological study

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ABSTRACT

Objectives: The aim of this study was to investigate the effects of kinesiotaping (KT) using facilitation and inhibition techniques on electrical muscle activity in the vastus medialis (VM) muscle in healthy individuals and to examine the relationship between the initial electrical activity level of the muscle and the changes in electrical activity that may occur after taping.

Patients and methods: Between May 2024 and August 2024, a total of 75 healthy female volunteers (median age: 32 years; range, 21 to 56 years) were included in the study. The maximum and mean amplitude values of electrical activity in the VM muscle were recorded during a six-second maximum voluntary isometric contraction. Surface electrodes were attached to the motor point of the VM muscle on the dominant leg. Measurements were taken three times: before the KT application and 30 min after KT applications using facilitation and inhibition techniques.

Results: Compared to before the KT application measurements, the maximum and mean amplitude values of electrical muscle activity significantly increased after the facilitation technique ($p<0.001$) and significantly decreased after the inhibition technique ($p<0.001$). Additionally, the maximum amplitude value recorded before KT was negatively correlated with the increase in maximum amplitude observed after facilitation, and positively correlated with the decrease in amplitude after inhibition.

Conclusion: Kinesiotaping applications using muscle techniques can modulate electrical muscle activity, either increasing or decreasing it. When before the KT application muscle activity is high, the facilitation effect is less pronounced, while the inhibition effect becomes more prominent.

Keywords: Electrophysiology, facilitation, inhibition, kinesiotaping, muscle activity.

Kinesiotaping (KT) was discovered in 1973 by Dr. Kenzo Kase, a Japanese chiropractor and acupuncturist.[1] It involves the application of specially designed elastic tapes, which are cut into various lengths and shapes, and applied to body parts. The primary goal of KT is to facilitate the body's natural healing process by supporting muscle and joint structures without restricting the range of motion. Kinesiotaping has been shown to provide numerous benefits, including pain reduction, improved circulation, edema reduction, enhanced muscle performance, proprioception improvement, neuromuscular reeducation, prevention of tissue damage, and accelerated tissue healing.[2] It is commonly used for conditions such as muscle pain and spasm, myofascial pain syndrome, joint instability, sports injuries, osteoarthritis, bursitis, tendinitis, entrapment neuropathies, posture disorders, and lymphedema.[3]

Kinesiotaping can be used independently or in combination with other methods in rehabilitation programs. In this context, important application purposes are facilitating weak muscles and correcting muscle imbalances by inhibiting overactive muscles. Therefore, muscle techniques aimed at facilitation and inhibition are integral components of KT applications.

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The facilitation technique is applied to support rehabilitation programs which aimed to strengthen weak muscles, enhance the muscle function. Inhibition technique is used to inhibit muscle activity in cases with muscle injury caused by overuse or tension, particularly in acute pain conditions and muscle spasms.[1] However, despite being commonly applied, the effects of these techniques have not been fully validated by research. There is a limited number of studies in the recent literature, aiming to objectively assess the effectiveness of these muscle techniques in both healthy individuals and various patient groups. Some of those studies have demonstrated that KT can enhance muscle strength and performance,[4,5] while others have shown its inhibitory effects on muscle spasms and spasticity in hyperactive muscles.[6,7] The most reliable way to assess whether muscle techniques objectively increase or decrease muscle activity is through electrophysiological methods. However, there is only a limited number of electrophysiological studies examining the specific effects of KT on muscle activity, and the results of these studies remain inconclusive and contradictory.[8-12]

Studies examining the effects of KT on electrical muscle activity have largely focused on healthy athletes or young, healthy male participants.[8,11,12] It has been suggested that KT may not provide enough stimulation to increase muscle recruitment in individuals with high muscle performance, such as athletes.[13,14] One study found that individuals with weak muscle KT application experienced a more significant improvement in muscle performance and strength after KT application with facilitation technique.[15] These findings suggest that the lack of significant changes in electrical muscle activity after KT may be related to the muscle's baseline activity level. However, no studies have specifically examined the relationship between pre-application electrical muscle activity and changes in muscle activity following KT. In the present study, we aimed to electrophysiologically evaluate the effects of KT applications with facilitation and inhibition techniques on vastus medialis (VM) muscle activity in healthy female volunteers and to investigate the relationship between the muscle's electrical activity level without any KT application and the amount of change in electrical activity that may occur after KT applications.

PATIENTS AND METHODS

This single-center, cross-sectional study was conducted at University of Health Sciences, Haydarpaşa Numune Training and Research Hospital, Department of Physical Medicine and Rehabilitation between May 2024 and August 2024. A total of 75 healthy female volunteers (median age: 32 years; range, 21 to 56 years) were included in the study. Exclusion criteria were individuals with neurological, rheumatological, cardiopulmonary, or orthopedic diseases that could affect lower extremity muscle strength and gait, those with a history of fractures or surgeries in the lower extremities, pregnant women, amateur or professional athletes. Written informed consent was obtained from each participant. The study protocol was approved by the Haydarpaşa Numune Training and Research Hospital Clinical Research Ethics Committee (date: 25.03.2024, no: HNEAH-KAEK 2024/44). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Data on age, sex, height, weight, and body mass index (BMI) were recorded for each participant. Kinesiotaping was applied to the dominant side VM muscle of the participants using two techniques: once with a facilitation technique and once with an inhibition technique. After applying KT with one technique, a one-week washout period was implemented before applying the other technique.[11] The order of application was randomized using sealed envelope method to eliminate any potential bias. Surface electromyography (EMG) was used to record electrical activity over the VM muscle during maximum voluntary isometric contraction. Measurements were taken a total of three times: once before the first KT application, and once after each KT application (for both techniques).

Kinesiotaping application method

For the KT applications, 5-cm wide cotton kinesiotapes (Kinesio Tex Tape, Kinesio Holding Corp., NM, USA) were used. Prior to application, volunteers' skin was tested for potential allergies by applying a small piece of tape to the inner surface of the forearm and evaluating the area for any allergic reactions after 15 min. Volunteers who exhibited signs of skin allergies were excluded from the study. While lying in a supine position, the origin and insertion points of the VM muscle were identified. The length of the tape was then determined by measuring the distance between the middle part of the anteromedial line of the femur and the medial corner of the patella. The kinesiotapes were cut to the appropriate size and in a Y shape.

For the facilitation technique, the tape was applied from the origin of the muscle to its insertion (proximal to distal), with the anchor of the Y-shaped tape applied to the muscle origin without tension. The knee was then placed in a semi-flexed position, and the arms of the tape were stretched to 15 to 35% (mild to medium tension) and applied around the two sides of the muscle. The tape's ends were joined and adhered without tension at the medial corner of the patella, which marks the muscle's insertion (Figure 1). For the inhibition technique, the tape was applied from the insertion to the origin of the muscle (distal to proximal), with the anchor placed at the muscle insertion without tension. The knee was again placed in semiflexion, and the arms of the tape were stretched to 15 to 25% (light tension) and applied around the muscle's two sides, ensuring that the ends of the tape were applied without any stretch. The taping was completed by attaching the ends of the tape to the muscle origin (Figure 2).[16]

Electrical muscle activity measurement

Superficial EMG was used to measure the effects of KT applied with inhibition and facilitation techniques on electrical muscle activity. Measurements were performed by a physical medicine and rehabilitation specialist experienced in electrophysiology, using a Chattanooga (USA) EMG biofeedback device. Recording electrodes were placed on the motor point of the VM muscle while the volunteers were seated with their knee fully extended (Figure 1). In this position, the volunteers were instructed to extend their knee with maximum force against resistance applied to the ankle, achieving maximum voluntary isometric contraction of the quadriceps muscle. During this isometric contraction, electrical activity in the muscle was recorded for 6 sec via superficial electrodes placed on the muscle. After the recording, two parameters automatically calculated by the device's software were evaluated. The highest amplitude electrical signal recorded during the 6-sec contraction was taken as the maximum amplitude (microvolts: μV) value. The mean amplitude (μV) value, calculated from the electrical signals recorded over the 6 seconds, was also evaluated. The maximum and average amplitude values from the three repeated recordings were averaged.

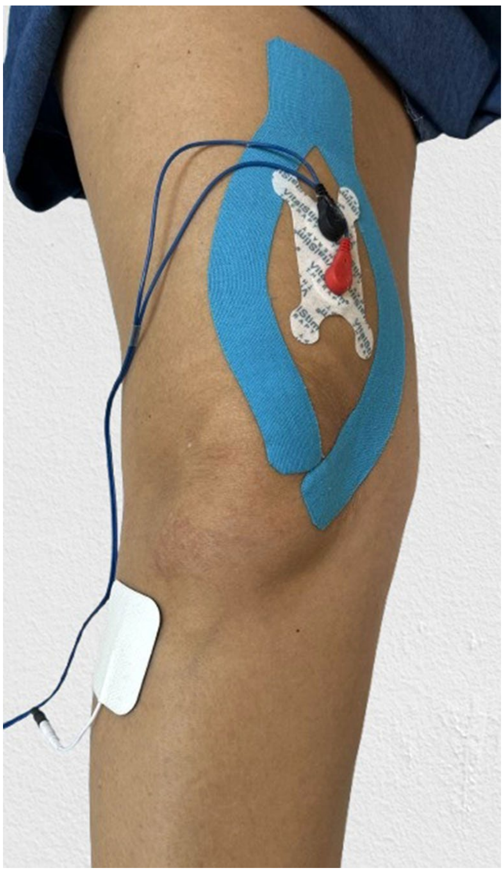

Figure 1. Kinesiotaping application with facilitation technique to vastus medialis muscle.

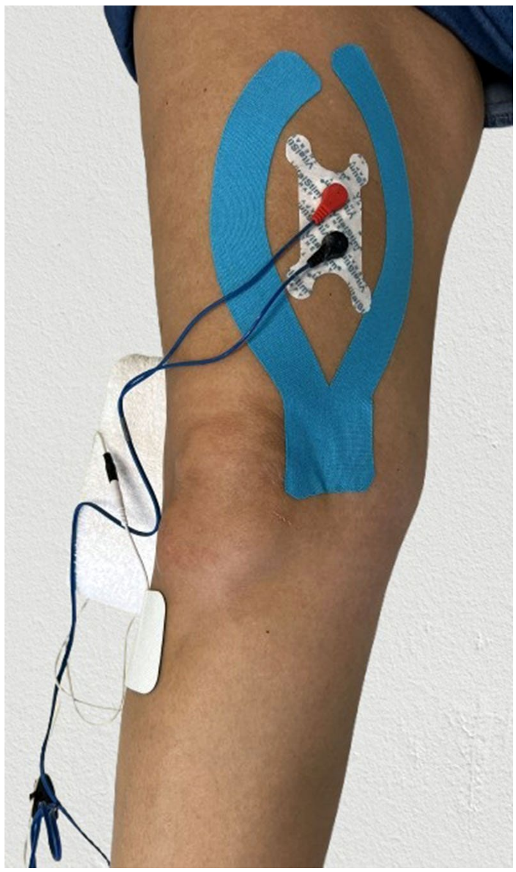

Figure 2. Kinesiotaping application with inhibition technique to vastus medialis muscle.

TABLE 1
Characteristics of participants (n=75)

	Mean±SD	Median	Min-Max
Age (year)		32	21-56
Height (meter)	1.6±0.06		
Weight (kg)		58	42-94
BMI (kg/m^2)		23.1	17.6-40

SD: Standard deviation; BMI: Body mass index.

Measurements were first taken before the KT applications to obtain baseline data, including the maximum and mean amplitude values of electrical activity prior to taping. Electrical activity was then re-evaluated using the superficial EMG device 30 min after the facilitation and inhibition KT applications, which were applied on separate days. The maximum and mean amplitude values recorded after the KT application with the facilitation technique, as well as those obtained after the inhibition technique, were analyzed. The effects of both methods on electrical activity were evaluated by comparing the mean and maximum amplitude values recorded after both the facilitation and inhibition KT applications with the baseline values obtained before the KT applications.

Statistical analysis

Study power analysis and sample size calculation were performed using the G*Power version 3.1 software (Heinrich Heine University Düsseldorf, Düsseldorf, Germany). The required number of participants was calculated based on data from the study by Sinaei et al.[10] The calculations indicated that 74 participants would be needed to achieve a power level of 0.90, with the following parameters: ($\mu1$=33,17; $\mu2$=39,56; S1=17,05; S2=19,08; R=0,5; α=0,05).

Statistical analysis was performed using the IBM SPSS version 25.0 software (IBM Corp., Armonk, NY, USA) Descriptive data were expressed in mean ± standard deviation (SD), median (min-max) or number and frequency, where applicable. The normality of the distribution of quantitative variables was tested using the Shapiro-Wilk test. Measurements recorded before and after the application were compared using the Wilcoxon signed-rank test. The relationship between quantitative variables was assessed using the Spearman correlation coefficient. A p value of <0.05 was considered statistically significant.

RESULTS

The height, weight, and BMI values of the participants are presented in Table 1.

The maximum amplitude value obtained through isometric maximal contraction of the VM significantly increased after KT application using the facilitation technique (p<0.001). Conversely, this value significantly decreased after KT application using the inhibition technique (p<0.001). The median value of the mean amplitude obtained before KT was observed to significantly increase following KT application with the facilitation technique (p<0.001), while it significantly decreased after KT application using the inhibition technique (p<0.001) (Table 2).

The relationships between the amount of change in maximum and mean amplitude values of the volunteers after facilitation and inhibition techniques and BMI, maximum amplitude (MAXAMP), and mean amplitude (MEANAMP) values before KT applications are shown in Table 3. A weak negative correlation was found between the maximum amplitude value before KT application and the amount of increase in maximum amplitude after KT application using the facilitation technique (p=0.028, r=−0.253), while a weak positive correlation was observed between the maximum amplitude before KT application and the amount of decrease in

TABLE 2
Comparison of the maximum and mean amplitude values before and after kinesiotaping

	Before KT		After KT		
	Median	Min-Max	Median	Min-Max	p*
MAXAMP-$_{\text{Facilitation(ųv)}}$	73.4	23.7-173	79.6	34.1-166	<0.001
MEANAMP-$_{\text{Facilitation (ųv)}}$	37.4	22.1-97.7	41.9	24.5-87.3	<0.001
MAXAMP-$_{\text{Inhibition (ųv)}}$	73.4	23.7-173	70.4	21.5-143	<0.001
MEANAMP-$_{\text{Inhibition (ųv)}}$	37.4	22.1-97.7	35.9	21-82.1	<0.001

AMP: Amplitude; KT: Kinesiotaping; * p<0.01; Wilcoxon test.

TABLE 3
The relationships between the changes in amplitude after kinesiotaping and BMI, before kinesiotaping amplitudes

	BT_{Max}-$AT_{Max\text{-}FAC}$	BT_{Mean}-$AT_{Mean\text{-}FAC}$	BT_{Max}-$AT_{Max\text{-}INH}$	BT_{Mean}-$AT_{Mean\text{-}INH}$
BMI				
Correlation coefficient	−0.104	−0.091	0.126	−0.016
p value	0.372	0.439	0.282	0.888
BT_{MaxAMP}				
Correlation coefficient	−0.253	−0.116	0.300	0.358
p value	0.028*	0.324	0.009**	0.002**
$BT_{MeanAMP}$				
Correlation coefficient	−0.173	−0.092	0.273	0.396
p value	0.137	0.434	0.018*	0.001**

BMI: Body mass index; AMP: Amplitude; AT: After taping; BT: Before taping; FAC: Facilitation; INH: Inhibition; Max: Maximum; * Correlation is significant at the 0.05 level; ** Correlation is significant at the 0.01 level; Spearman test.

maximum amplitude after KT application using the inhibition technique (p=0.009, r=0.300) (Table 3).[17]

DISCUSSION

In the present study, we evaluated the effects of KT applications with facilitation and inhibition techniques on VM muscle activity in healthy female volunteers. Our study results demonstrated that KT could facilitate and inhibit muscles by means of changes in electrical activity. In the literature, several studies have evaluated the effects of KT on electrical activity in muscles. Bagheri et al.[18] conducted a study on the soleus and lateral gastrocnemius muscles, revealing that KT application with inhibition technique altered activity in the gastrosoleus motor neuron pool by stimulating cutaneous receptors and inhibited H-reflex recruitment parameters. In another study, a significant decrease was found in both the mean and peak values of EMG activity in the tensor fascia lata and gluteus maximus muscles following KT applications using inhibition technique to the iliotibial band region in healthy runners.[19] In the study by Huang et al.,[20] KT application increased medial gastrocnemius EMG activity during vertical jumping movements in healthy, inactive individuals. The results of these studies, conducted on various muscle groups other than the VM, are consistent with our findings that VM electrical activity can be modified after KT application.

In some studies, the effects of KT on electrical activity were examined in the VM muscle, as in our study. Sinaei et al.[10] and Słupik et al.[9] showed that there was an increase in bioelectric activity in the muscle after KT was applied to the VM using facilitation technique in healthy individuals, similar to our findings. Lee et al.[21] reported reduced EMG activity in the VM and vastus lateralis muscles after applying inhibition technique in patients with patellofemoral pain syndrome, similar to the findings of our study. The main difference of our study from these studies with similar findings is that it also reveals the relationship between changes in muscle electrical activity after KT and the baseline electrical activity levels measured before KT application.

Contrary to our findings, some studies have shown that KT has no effect on electrophysiologically evaluated muscle activity.[11,12,22-24] In most of these studies, the sample size is too small (range, 17 to 33), and the volunteers are often very young age (range, 18 to 28 years).[23,24] In contrast to these studies, it is of utmost importance to note that our study involved a larger number of volunteers and a wider age range than most studies in the literature. Furthermore, in some studies, there are methodological deficiencies. To illustrate, the authors compared the data of the inhibition technique, facilitation technique and sham KT of different groups, rather than comparing the data before and after KT of the same individuals.[22,24] The fact that some studies were conducted on healthy athletes limits the generalizability of their findings.[11,24] It is believed that the tactile stimulation provided by KT is not strong enough to create a noticeable response in the muscles of healthy athletes.[13] Thus, amateur or professional athletes were not included in our study.

Review of the literature reveals that it is evident that KT applications with inhibition technique are effective in the treatment of spasticity.[6,7,25,26] Although these studies do not perform electrophysiological evaluations, they clinically demonstrate that KT can inhibit muscle activity in spasticity, a condition characterized by increased muscle activity. These findings support our results, suggesting that muscles with high electrical activity can be inhibited more effectively.

Some studies have examined the effects of KT on muscles by evaluating changes in parameters such as muscle strength and performance. Cheung et al.[27] revealed that KT application in volleyball players did not lead to an increase in muscle performance that could affect vertical jumping. Fu et al.[13] found KT using facilitation technique applied to the quadriceps and hamstring muscles in healthy young athletes had no effect on muscle strength. Vercelli et al.[28] showed that KT had no effect on quadriceps strength in healthy individuals who engage in regular physical activity at least twice a week. Gómez-Soriano et al.[29] demonstrated that KT applications led to a short-term increase in activity in healthy muscles, but did not result in changes in tone or strength in these muscles. Alabbad and Muaidi[14] did not find any performance-enhancing effects of KT applied to the lower extremities in elite weightlifting athletes. Considering these studies, it becomes clear that studies conducted on athletes did not show a significant effect of KT on muscle activity. In our study, muscles with high electrical activity before KT showed low level increase in electrical muscle activity after the application of the facilitation technique with KT.

Although KT applications are not found to be sufficiently effective in individuals with high muscle performance, such as athletes, there are studies that support its significant facilitation effect in cases of low muscle activity caused by diseases of locomotor system or inadequate muscle use. Altaş et al.[4] demonstrated that KT application with facilitation technique to quadriceps muscle increased extensor muscles of knee strength and performance in patients with knee osteoarthritis. Similarly, Anandkumar et al.[30] showed that isokinetic quadriceps torque increased after KT application with facilitation technique to rectus femoris muscle in patients with knee osteoarthritis. The facilitatory effect of KT on weak muscles was demonstrated by Yam et al.[31] in children with developmental coordination disorder and walking problems. This study suggested that KT applied with the facilitation technique resulted in an increase in EMG activity in the gastrocnemius medialis muscle. In another study, it was shown that KT application in individuals with low physical activity could lead to an increase in EMG activity and push of force in the medial gastrocnemius muscle.[20] These findings support the idea that KT application with facilitation technique may be more effective in individuals with low muscle activity due to various reasons. These results are also consistent with our findings that muscles of individuals with lower muscle activity before KT can be more facilitated with KT.

The data found in the literature suggest that the amount of effect observed after KT application may be related to the muscle strength and performance the individual has before the application. Csapo et al.[15] investigated the impact of the muscle's strength before KT on the results of KT application using the muscle strength parameter. This study, similar to our findings, showed that the initial muscle strength was negatively related to the potential for muscle strength increase after KT application. To the best of our knowledge, there is no study in the literature investigating this relationship through electrical muscle activity. In this sense, our study uniquely highlights the importance of pre-application muscle activity in KT applications with facilitation and inhibition techniques, through an electrophysiological perspective. A meta-analysis demonstrated that KT applications did not result in muscle strength gain in healthy individuals.[32] Another meta-analysis showed that KT applications were effective in increasing lower extremity muscle strength in individuals with lower extremity muscle weakness and chronic musculoskeletal conditions. Therefore, the authors suggested that KT might not be considered for improving functional performance in healthy individuals without disability.[33]

The main limitations to our study include the lack of measurements at follow-ups after KT application to assess how long the effect lasts, and the failure to use a control group to determine whether similar changes in electrical activity would occur with sham KT. Additionally, as we only included female volunteers in our study to ensure homogeneity in muscle activity based on sex, it is difficult to generalize the results.

The main strengths of our study include its large sample size and being the first study to reveal the relationship between muscle electrical activity levels before KT application and the amount of changes in muscle electrical activity after application. There is a need for studies to explore the effects of KT on muscle electrical activity in rehabilitation patients with weak, spastic, or hyperactive muscles.

In conclusion, KT muscle techniques have been shown to induce inhibition and facilitation in muscles through electrical muscle activity measurements. Additionally, we found that individuals with high electrical muscle activity before KT experienced greater reductions in muscle activity with the inhibition technique, while those with low electrical muscle activity showed a greater increase with the facilitation technique. Therefore, it seems to be convenient to include KT applications in rehabilitation programs when muscle inhibition or facilitation is desired due to various diseases.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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