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ORIGINAL ARTICLE

Hemiplejik omuzda bantlama ile nöromüsküler elektrik stimülasyon sonuçlarının karşılaştırılması: randomize kontrollü çalışma

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Amaç: Omuz fonksiyonu, inme sonrası hayatta kalanların bağımsızlık kazanmaları için önemli bir rol oynar. Bu çalışmanın amacı, inme geçiren hastalarda omuz bantlama (Tp) ve nöromüsküler elektrik stimülasyonunun (NMES) omuz fonksiyonu, motor aktivite ve ağrı üzerindeki etkilerini karşılaştırmaktır.

Yöntem: Çalışmaya üst ekstremite tutulumu olan inme hastaları alındı. Altmış hasta, inmeden 1-3 ay sonra bantlama grubu (TpG), NMES veya kontrol gruplarına (CG) rasgele ayrıldı. Tedavi süresi 4 hafta idi. Omuz fonksiyonel değerlendirmede Fugl–Meyer Duyu Motor Değerlendirme Ölçeği (FMDDÖ) ve Motor Aktivite Log-28 (MAL) kullanıldı. Omuz ağrısı değerlendirmesinde Görsel Analog Skala kullanıldı.

Bulgular: Grup içi karşılaştırmalarda FMDDÖ (TpG p≤0,001; NMES p=0,002; CG p≤0,001) ve MAL skorlarında (TpG p≤0,001; NMES p≤0,001; CG p ≤0,001) istatistiksel açıdan anlamlı gelişmeler bulundu. Grup içi karşılaştırmalar hem istirahatte omuz ağrısı yoğunluğunda (TpG p=0,007 ve NMES p=0,014) hem de aktivite ile (TpG p≤0,01 ve NMES p=0,016) anlamlı bir azalma gösterirken, CG'de hem istirahatte hem de aktivite ağrısı ile anlamlı bir azalma saptanmadı (her ikisi için p=0,054). Gruplar arası karşılaştırmalar, FMDDÖ'lerde TpG lehine önemli bir değişiklik (p=0,0026) gösterdi (p≤0,001). Grup karşılaştırmalarında MAL'de fark saptanmadı (p>0,05).

Sonuç: İnme hastalarının konservatif tedavisinde, etkilenen omuzda izole motor aktivitesini arttırmak için bantlama ve NMES kullanılabilir; ancak, fonksiyon için destekleyici bantlama daha etkili olacaktır.

Anahtar Kelimeler: Hemipleji; Omuz; Atletik bant; Elektrik stimülasyonu; Motor aktivitesi.

A comparison of taping and neuromuscular electric stimulation outcomes in hemiplegic shoulder: a randomized controlled trial

Purpose: Shoulder function plays an important role for survivors to gain independency after stroke. The aim of this study was to compare the effects of shoulder taping (Tp) and neuromuscular electric stimulation (NMES) on shoulder function, motor activity, and pain in patients with hemiplegia.

Methods: Outpatients with upper extremity involvement were enrolled in the study. Sixty patients were randomly assigned to kinesio taping group (TpG), NMES, or control groups (CG) after 1-3 months of stroke. Treatment duration was 4 weeks. The Fugl–Meyer Sensorimotor Assessment Scale (FMSAS) and the Motor Activity Log-28 (MAL) were used for shoulder functional assessment. A Visual Analog Scale was used for shoulder pain assessment.

Results: Statistically significant improvements in the FMSAS (TpG p≤0.001; NMES p=0.002; CG p≤0.001) and MAL scores (TpG p≤0.001; NMES p≤0.001; CG p≤0.001) were found in within-group comparisons. Within-group comparisons showed a significant decrease in shoulder pain intensity both at rest (TpG p=0.007 and NMES p=0.014) and with activity (TpG p≤0.01 and NMES p=0.016), whereas no significant decrease was found in the CG either at rest or with activity pain (p=0.054 for both). Between-group comparisons revealed a significant change (p=0.0026) in the FMSAS in favour of TpG (p≤0.001). No difference was found in the MAL in between-group comparisons (p>0.05).

Conclusion: In the conservative treatment of patients with hemiplegia, taping and NMES options could be used to increase isolated motor activity on the affected shoulder; however, if function is desired, kinesio taping would be more effective.

Keywords: Hemiplegia; Shoulder; Athletic tape; Electric stimulation; Motor activity.

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Hemiplegia in the upper extremity and especially in the shoulder-arm complex is a common secondary impairment caused as a result of a cerebrovascular event.[1] Although most stroke survivors regain independent ambulation, many fail to regain functional use of their impaired upper extremity.[2] The lack of functional ability in the shoulder girdle after stroke restricts the use and causes asymmetric posture and contracture in daily life, thus exacerbates functional limitations of the upper extremity. Also, decreased motor function in the shoulder region is related to pain and the risk of soft tissue injury during both acute and chronic stages.[3] Different muscle groups may be vulnerable to overstretching, increased contraction, and premature fatigue in the shoulder, which can decrease the motor activity and inhibit the functional use of the upper extremity. The posterior part of the deltoid, the supraspinatus, and the infraspinatus are the most important muscles that stabilize the glenohumeral joint.[4] Therefore, supporting these muscles after stroke plays an important role for the rehabilitation of the upper extremities.

Different tapes and taping techniques are used to treat the hemiplegic shoulder.[5-7] Kinesio® taping is a relatively new technique used to treat hemiplegic shoulder pain.[8] Kinesio® taping with other therapeutic interventions may promote muscle function, reduce pain, and improve proprioceptive feedback to obtain a correct body alignment.[7,9] There are studies showing the effects of Kinesio® taping on hemiplegic shoulder pain by comparing with sham taping.[8,10] Furthermore, the effects of the neuromuscular electric stimulation (NMES) and Kinesio® taping on pain in patients with acute hemiplegic shoulder pain were reported to be similar to those of conservative treatments in a study performed by Hochsprung et al.[11] Still more evidence-based research is needed to identify the best taping methods for patients with a hemiplegic upper extremity, who are likely to regain upper extremity function.[5,12]

NMES is an approach that may be effective to restore function in hemiplegic shoulder pain.[13,14] Studies show that NMES application improves upper extremity function in hemiplegic shoulder pain[15,16] and also has a specific effect that enhances function.[17,18] NMES has been cited to be one of the promising methods of treatment for hemiplegic shoulder pain[1] especially in acute and subacute stages.[19,20]

The aim of this study was to compare the effects of different conservative treatment approaches, namely taping and NMES, on shoulder function, motor activity level, and pain in patients with hemiplegia. We hypothesized that there would be differences between these two conservative intervention methods used in hemiplegic shoulder treatment in terms of the measured parameters.

METHODS

The study design was a single-blind, randomized, controlled trial with a 1-month follow-up aiming to compare the effects of the interventions on the affected side.

Subjects

Participants were recruited among the patients admitted to the University Hospital. Patients not using any medicine that may affect the treatment protocol recruited in this study satisfied the following inclusion criteria: (1) history of hemiplegia within 1-3 months after unilateral ischemic brain injury or intracerebral hemorrhage without other neurological or systematic deficits diagnosed; (2) a Brunnstrom score less than 4 for upper extremity (3) sufficient cognitive ability to follow the training protocol as assessed by the Mini Mental State Examination (MMSE>21); (4) ability to walk independently to attend the treatment; (5) age 30–70 years, (6) medical and neurological stability according to neurological examination and medical history, and (7) moderate to severe motor impairments in the upper extremity according to the Fugl Meyer Sensorimotor Assessment Scale (FMSAS) for upper extremity (15 <FMSAS<45 with a maximal score of 60).[21]

Patients were excluded if they (1) had severe shoulder problems (rotator cuff injury, shoulder surgery history or subluxation), (2) had any contraindication to inhibit physiotherapy applications, (3) existing shoulder degeneration or pain prior to stroke or (4) had more than one stroke.

The experimental protocol was approved based on the ethical standards of the Declaration of Helsinki. The study was approved by the local human research ethics committee (Inonu University, #2016/38, Date: 24/02/2016). Participants were informed prior to randomization and data collection, and their consents were obtained.

Patient Allocation

All patients received standardized physiotherapy and rehabilitation applications including Bobath's neurophysiological approach for 45 minutes, five days a week for 4 weeks. In addition to the physiotherapy program, patients were randomly assigned to the taping (TpG), NMES (NMES), or control groups (CG) (Figure 1). Concealed block randomization was used. Type I error (α) was set at 0.05, and the power of the test was 0.80 to statistically significantly show a clinically important difference of 30 units for the change in motor activity from baseline following treatment assuming a variation of 20 points for this change. Considering this, the calculated sample size showed that a sample size of 20 patients in each group was appropriate to test the hypothesis and obtain reliable results.[22]

Assessment

Each patient was assessed on admission to the rehabilitation department by a physiotherapist. The assessments were repeated at the end of the 1-month treatment for follow-up results. The same physiotherapist blinded to group allocation made all the assessments. The interventions were performed by another physiotherapist.

The FMSAS, the primary assessment tool, is an impairment assessment tool that has been shown to be reliable[23] and valid.[24] In the present study, only the section of the FMSAS assessing the upper extremity was used. This hemiplegia-specific assessment tool is used to assess the level of recovery in hemiplegic patients. The higher score indicates better function.[25] The coordination-speed parameter was not evaluated in the present study, and 7 sub-parameters and 60 points were included in the analyses. Assessments were performed by a trained physiotherapist on a one-to-one basis with each patient. The patients were assessed in sitting position.

The second assessment tool was the Motor Activity Log-28 (MAL), which is a clinical questionnaire developed to evaluate the daily use of the hemiparetic arm outside of the treatment setting.[26] The MAL assesses the upper extremity movements in two sections. In the first section, the use amount of the affected upper extremity is assessed in performing 28 daily activities (use of cutlery, combing, etc.), and in the second section, the quality of movement, if an activity is performed, is assessed.[26] In both sections, patients score themselves in a range between 0 and 5 (0= Not using the involved extremity, 5=the same amount/quality of use of the affected extremity compared to pre-stroke). The total score of each section is summed up and divided by the number of the questions to obtain the mean score. MAL is reliable and valid in individuals with subacute stroke.[27] The Turkish version of the MAL, which was used in this study, was shown to be valid and reliable in a hemiplegic population.[28]

The intensity of shoulder pain on the affected side was scored using a 100-mm visual analog scale.[29] The patients rated the pain intensity in their affected side as experienced over the last 24 hours by marking on a 100-mm horizontal line, in which 0 denotes no pain and 100 mm denotes the maximum pain felt by the patient. The pain felt with activity and at rest was recorded separately. Activity pain explains the pain felt during any activity performed by the affected shoulder. Rest pain explains the intensity of pain felt all the time during the day.

Interventions

Taping Group (TpG)

Kinesio® tape was used in this group. Facilitative techniques were used for both muscles. A physiotherapist trained in the field performed all taping sessions. The deltoid and supraspinatus muscles were taped in this study to align the shoulder in the correct position to facilitate function and achieve a preferred body alignment.[30] As for the supraspinatus muscle, a Y-strip tape was applied from the muscle origin at the supraspinatus fossa of the scapula to its insertion at the greater tuberosity of the humerus while the muscle was in an overstretched position. The front tail was implemented in the extended arm position while the back tail was implemented in internally rotated position to achieve the tissue tension. A tension of 15%-30% tension was applied to the tape. As for the deltoid muscle, the anchor was placed at the acromion and again a Y-strip tape was used. The front tail was implemented in the extended arm position, while the back tail was

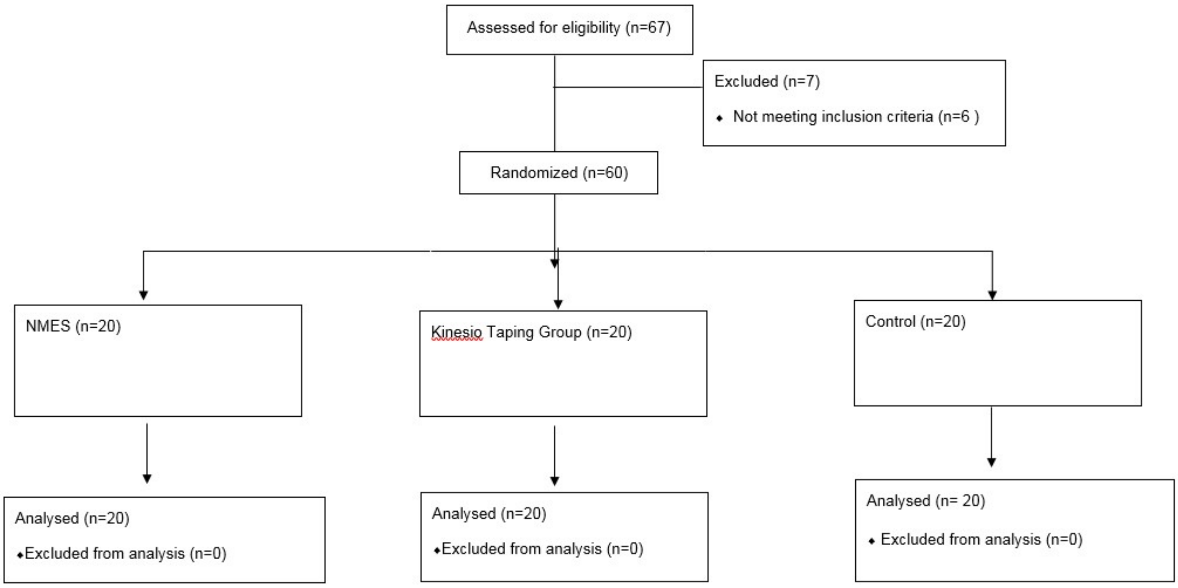

Figure 1. Flow chart diagram for patient selection and allocation.

Figure 2. Facilitation method was used as Kinesio taping method in the study. The same practitioner taped both deltoid and supraspinatus muscles.

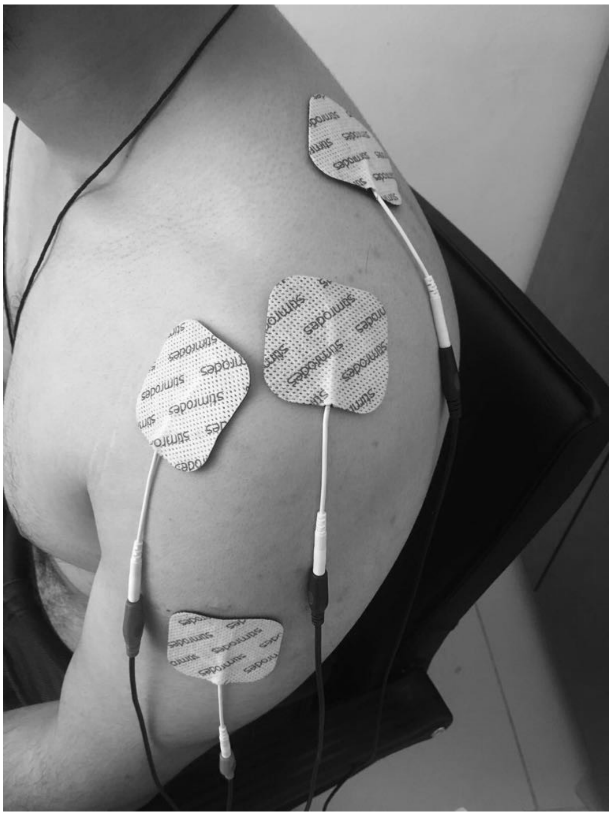

Figure 3. Application of the NMES and electrode pad placement locations.

implemented in the horizontally adducted arm position. Both tails ended at the deltoid tubercle of the humerus. A tension of 15%-30% was applied during application (Figure 2).

The patients were instructed to come back to the clinic for re-application on day 4. On day 4 of the follow-up, the investigator inspected the patients' skin for any adverse effects due to taping, re-taped using the same method as before, and instructed the patients to keep the tape on for an additional 4 days. This procedure continued until the end of study. On the final day, second measurements were carried out.

NMES Group (NMES)

Participants were treated with NMES with a portable, page-sized battery-powered stimulation device, which delivered current-regulated, charge-balanced, asymmetrical biphasic pulses. The stimulator's frequency (30–50 Hz) and duty cycle (10 sec on, 50 sec off) were kept constant, and the ramp-up was set at 5 s. The stimulus intensity was adjusted to provide a muscle contraction without exceeding the pain threshold. Implementations were carried out on the deltoid and supraspinatus muscles.[15] The placement locations of the probes on muscles are shown in Figure 3. Patients received the NMES treatment for 30 minutes per day, five days a week for 4 weeks.

Control Group (CG)

All participants received rehabilitation involving Bobath's approach for 45 minutes a day, five days a week for 4 weeks. TpG and NMES groups received this protocol after their initial treatments, namely, taping and NMES, respectively. Bobath's approach and other exercise programs are used early after the onset of the stroke to prevent immobility and soft tissue contracture and to alter the muscle tone to gain mobility. Through the exercise program and the use of weight-bearing techniques, the physiotherapist attempts to maintain and improve trunk and shoulder alignment to allow the functional use of the upper extremity.[31] The exercises applied in this study were selected and adapted individually based on the need of each patient. The physiotherapy program included scapular mobilization, upper extremity weight bearing, auto-inhibition techniques, latissimus dorsi muscle stretching, bridging, and gait training.

Statistical analysis

The Kolmogorov–Smirnov test was used to assess the normality of distribution for the variables tested (FMSAS, motor activity, and shoulder pain at rest and with activity). Continuous variables were expressed as mean±standard deviation (SD), median (minimum-maximum values), and categorical variables as number and percent. Shapiro–Wilk test was used for testing normality. If parametric test conditions were satisfied, One Way Analysis of Variance (ANOVA) was used for comparisons among groups. The post-hoc Tukey test was used when the ANOVA yielded a significant difference. If parametric test conditions were not satisfied, the Kruskal–Wallis Variance Analysis was used for comparisons among groups. The post-hoc Mann Whitney U-Test with Bonferroni Correction was used when the Kruskal Wallis Variance Analysis yielded a significant difference. For paired samples comparisons, if parametric test conditions were satisfied, the Paired Samples t test was used, and if parametric test conditions were not satisfied, the Wilcoxon Signed Rank Test was used. The differences between categorical variables were examined by Chi-square analysis. Also, mean differences and minimal detectable change examinations were used for the changes in pre- and post-measurements, and a p value less than 0.05 was considered statistically significant. All analyses were performed according to the intention-to-treat principle.

RESULTS

Sixty patients were recruited into the study. Demographics and descriptive characteristics of the patients in each group at baseline are shown in Table 1. In taping and NMES groups, 19 of the patients were right-handed while in the control group all patients were right-handed. In the NMES group, 55% of the patients' affected side was dominant side. This percentage was 75 in the taping group and 50 in the control group. The patient selection flow diagram is provided in Figure 1, which reports the numbers and timing of randomization assignment, interventions, and measurements for each group. All the data were analyzed according to the patients' initial allocation. It was determined that demographical characterization and medical assessments of the three groups were similar at baseline.

Function

FMSAS values were calculated for all sub-parameters separately. Within-group and between-group comparison results are shown in Table 2.

Statistical analyses showed that all different conservative treatment approaches lead to a significant improvement in all sub-parameters of the FMSAS in post-treatment values compared to pre-treatment values (TpG $p \leq 0.001$; NMES $p \leq 0.001$; CG $p \leq 0.001$ for total score) (Table 2).

Between-group comparisons show a significant difference in the total score of the FMSAS (Kruskal–Wallis, $p=0.026$) and motion without synergy (Kruskal–Wallis, $p=0.004$) in favor of the TpG (Table 2).

Minimal clinical change results and mean change results are presented in the same table (Table 3). The total score of the FMSAS was calculated as 12.5, 5.1, 6.8 for the TpG, NMES, and CG, respectively. Minimal clinical importance was found as 5.72, 6.08, and 5.82, respectively (Table 3).

Motor Activity

A significant increase was found in both the quality (TpG $p \leq 0.001$; NMES $p \leq 0.001$; CG $p \leq 0.001$) and the amount of use (TpG $p \leq 0.001$; NMES $p \leq 0.001$; CG $p \leq 0.001$) within groups (Table 4). No significant differences were found between groups in the follow up assessment when the quality ($p=0.380$) and the amount of use ($p=0.667$) were compared (Table 4).

Pain

Within-group comparisons showed a significant decrease in pain intensity at rest and with activity in both TpG and NMES groups, whereas no significant difference was found in pain scores in the CG (Table 4). Between-group comparisons revealed no significant difference in both activity ($p=0.961$) and rest pain ($p=0.869$) (Table 4).

DISCUSSION

This single-blinded, randomized study aimed to compare the effects of NMES and supportive shoulder taping in subacute stage hemiplegia patients. Improvements in the FMSAS and MAL were observed post-treatment in all groups. Furthermore, pain scores reduced by treatment in both NMES and TpG, but not in CG. All approaches and techniques were safe and no adverse effects were detected during the study.

The shoulder is the least supported joint in the body due to the surrounding joint capsule and its connective tissues, tendons, labrum, and surrounding muscles.[32] The movements of the upper extremity are impaired and performing daily tasks becomes difficult after stroke.[33] We aimed to see the effects of stabilization on function, motor activity, and pain by supporting the surrounding tissue using either TpG or NMES.

After the study, improvements were observed in function in all three groups. Minimal detectable change scores for function was high in both TpG and NMES after 4 weeks of treatment. This change is a apparently higher minimal clinical change between 4.25 and 7.25 points[18], which could be interpreted as an indication that the treatment modalities in the present study were sufficient in improving function.

In the present study, a significant decrease in pain was found both at rest and with activity in both taping and NMES groups, whereas no significant decrease in pain was found neither at rest nor with activity in the control group, which was treated with the neurophysiological approach only. These findings might be the result of the facilitative effect of NMES and taping approaches on active movements and their mobilizing effects. Functional gains were limited in patients with hemiplegia suffering from high-intensity shoulder pain, and that shoulder pain affected the upper extremity functions.[34] Lack of active movements and spasticity are the most important causes of shoulder pain.[35] In this regard, active muscle contraction caused by NMES treatment increases the muscle activity, which is thought to lead to a decrease in pain intensity. Studies comparing pain intensity in shoulders with spasticity showed that pain intensity increases as the intensity of spasticity increases and the intensity of shoulder pain was lower in patients with stronger muscles.[29]

In similar studies in the literature, significant improvements in pain as a result of taping techniques have been reported.[10,11] Conversely, Huang et al.[8] found no significant changes in both pain and ultrasonography

Table 1. Patients' demographic characteristics.

	NMES Group (n=20)	Taping Group (n=20)	Control Group (n=20)	
	X±SD	X±SD	X±SD	p
Age	57.5±6.39	53.4±8.01	49.35±13.53	0.130 (KW)
Height (cm)	170.4±8.92	166.75±8.67	167.1±6.13	0.101 (F)
Weight (kg)	77.75±13.71	70±9.88	71.35±7.82	0.081 (KW)
	n (%)	n (%)	n (%)	n (%)
Gender (Female/Male)	8/12 (60/40)	11/9 (55/45)	10/10 (50/50)	0.817 (X^2)
Stroke side (right/left)	10/10 (50/50)	14/6 (70/30)	10/10 (50/50)	0.338 (X^2)
Dominant side (right/left)	19/1 (95/5)	19/1 (95/5)	20/0 (100/0)	0.437 (X^2)
Effected side (dominant/non-dominant)	11/9 (55/45)	15/5 (75/25)	10/10 (50/50)	0.233 (X^2)

NMES: Neuromuscular electric stimulation. X^2: Chi Square Test. KW: Kruskal Wallis Variance Analysis Test. F: One Way ANOVA.

Table 2. Fugl–Meyer Sensorimotor Assessment Scale scores, within-group and between-group comparisons and distribution of each stage.

	NMES Group	Taping Group	Control Group	
	X±SD	X±SD	X±SD	p
Flexor synergy baseline	4.2±3.78	3.25±3.74	4.05±4.5	0.730 (KW)
Flexor synergy post-treatment	5.95±3.89	8.35±3.1	6.55±3.98	0.117 (KW)
Within-group p	0.020 (z)	<0.001 (z)	0.003* (z)	
Extensor synergy baseline	2.1±1.86	1.85±1.87	2.15±2.43	0.940 (KW)
Extensor synergy post-treatment	3.65±2.08	4.3±1.45	3.6±2.04	0.548 (KW)
Within-group p	0.004* (z)	<0.001 (z)	0.003* (z)	
Motion with mixed synergy baseline	2.3±1.87	1.95±1.82	1.7±2.15	0.470 (KW)
Motion with mixed synergy post-treatment	3.3±1.59	4.15±1.23	3.25±2.1	0.135 (KW)
Within-group p	0.015* (z)	<0.001 (t)	<0.001 (z)	
Motion without synergy baseline	2.25±1.62	1.65±1.98	1.8±2.24	0.333 (KW)
Motion without synergy post-treatment	2.95±1.47	3.9±1.17	2.75±2.07	0.040* (KW)a
Within-group p	0.010* (z)	<0.001 (t)	0.003* (z)	
Total score baseline	11.85±8.92	10±9.37	10.4±11.58	0.724 (KW)
Total score post-treatment	16.95±7.78	22.5±6.14	17.25±9.89	0.026* (KW)b
Within-group p	0.002* (z)	<0.001 (t)	<0.001 (z)	

*p<0.05. NMES: Neuromuscular electric stimulation. t: Paired Samples t Test. z: Wilcoxon Signed Rank Test.
KW: Kruskal Wallis Variance Analysis Test. F: One Way ANOVA Test. a: Difference between Taping-Control. b: Difference between NMES-Taping.

Table 3: Within-group change and minimally detectable clinal change in the Fugl–Meyer Sensorimotor Assessment Scale scores for each treatment protocol.

	Within-group change at follow up mean change (95% CI)			MDC (95% Level)		
	NMES Group	Taping Group	Control Group	NMES-TpG	NMES-CG	TpG-CG
Reflex activity	0.10 (0.10-0.30)	0.5 (0.08-0.91)	0.40 (0.01-0.78)			
Flexor synergies	1.75 (0.21-3.28)	5.1 (3.8-6.3)	2.5 (1.25-3.74)	4.19	3.95	3.89
Extensor synergies	1.55 (0.60-2.49)	2.45 (1.76-3.13)	1.45 (0.71-2.18)	3.2	2.94	3
Motion with mixed synergy	1.0 (0.27-1.72)	2.2 (1.56-2.83)	1.55 (1.01-2.08)	3	2.85	2.51
Motion without synergy	0.7 (0.12-1.27)	2.2 (1.62-2.87)	0.95 (0.45-1.44)	2.63	2.73	2.42
Total score	5.1 (2.08-8.1)	12.5 (9.7-15.2)	6.8 (4.04-9.6)	6.08	5.72	5.82

NMES: Neuromuscular electric stimulation; TpG: Taping Group; CG: Control group; CI: Confidence Interval; MDC: Minimal Detectable Change.

Table 4. Distribution of motor activity and pain assessments.

	NMES Group (N=20) X±SD	Taping Group (N=20) X±SD	Control Group (N=20) X±SD	Between Group p
Motor activity				
Quality baseline	29.9±31.22	27.5±23.98	28.78±30.08	0.967 (KW)
Quality post-treatment	60.18±35.63	66.65±29.67	52.73±36.64	0.439 (F)
Within-group p	<0.001 (z)	<0.001 (t)	<0.001 (t)	
Amount of use baseline	30.45±34.64	31.35±28.03	31.3±29.92	0.998 (KW)
Amount of use post-treatment	52.85±30.98	64.9±24.23	51.4±29.22	0262 (F)
Within-group p	<0.001 (z)	<0.001 (z)	<0.001 (t)	
Pain				
Rest pain baseline	30±23.62	31±18.32	23.5±17.25	0.434 (KW)
Rest pain post-treatment	21.5±14.96	21.5±17.55	19.5±15.04	0.869 (KW)
Within-group p	0.014* (z)	0.007* (z)	0.054 (z)	
Activity Pain baseline	41.5±24.98	46.5±25.6	33±22.27	0.200 (KW)
Activity Pain post-treatment	29.5±18.2	31.5±22.07	29±18.32	0.961 (KW)
Within-group p	0.016* (z)	0.01* (z)	0.054 (z)	

*p<0.05. NMES: Neuromuscular electric stimulation. t: Paired Samples t Test. z: Wilcoxon Signed Rank Test.
KW: Kruskal Wallis Variance Analysis Test. F: One Way ANOVA Test.

findings following a one-month treatment and they associated this outcome to the fact that taping does not affect structural anomalies.[8] The present study is different than the study performed by Huang et al. because the present study involved a higher number of participants and NMES and Kinesio® taping were used in the present study instead of sham taping. Pain and changes in the muscle tone affect the functionality of the upper extremities in the range of 30%–60%, which also limits the functionality of the patients and the physiotherapy process, and consequently affects the quality of life adversely.[31] In two studies, it has been reported that the cutaneous stimulation by Kinesio® taping application decreased pain and improved proprioceptive sensation and muscle tone regulating properties.[36,37]

NMES is reported to be efficient in preventing the development of atrophy resulting from not using the muscles in stroke cases. NMES protects and increases the ranges of active joint motion and stabilization of the shoulder region by strengthening the muscles of the upper extremities and decreasing spasticity.[38] Other values related to functionality improved post-treatment in all groups. However, functional values of the NMES group were better than those of the other two groups. This finding was in agreement with the results of other similar studies.[39] Yet, this study is important considering that it compared three different methods commonly used in the rehabilitation of the upper extremity hemiplegia.

In recent years, Kinesio® taping has been used with other methods to treat neurological diseases. Taping methods are used owing to their effects on proprioception and mechanoreceptors, and their muscle-strengthening and muscle-tone-regulating properties.[30] Although the mechanism of action of the treatment is not entirely understood, it is presumed that neurofacilitation positively affects pain, spasticity, functional activities, and walking pattern. It has been suggested that the use of Kinesio® taping together with other treatment methods could be beneficial.[8,10,12] It was thought to be due to the applied elastic tape and the reduction of pain without limiting the movement.

Limitations

The present study reported 1-month follow-up values belonging to patients with a history of stroke within the previous 3 months and did not report any longitudinal data. Furthermore, spontaneous improvements during the acute phase of the stroke were not considered during the interpretation of the results.

Conclusion

This study shows that Kinesio® taping can be used as an adjunct to neurophysiological therapy during a rehabilitation program to enhance functional recovery by reducing pain, improving alignment, stimulating or inhibiting muscle function, and improving the proprioceptive function of the joint structure. All treatment options, which can be safely used in hemiplegia patients with upper limb dysfunction, have a positive effect on pain, function, and motor ability. These results show that, in the treatment of symptomatic shoulders in hemiplegic patients, both options can be used to improve isolated motor activity; however, if function is specifically targeted, kinesio taping would be a better option.

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