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Effect of Modified Constraint-Induced Movement Therapy on Upper Extremity Function for Stroke Patients with Right/Left Arm Paresis: A Single-Blind Randomized Controlled Trial

Sağ/Sol Kol Parezisi Olan İnmeli Hastalarda Modifiye Zorunlu Kullanım Tedavisinin Üst Ekstremite Fonksiyonu Üzerine Etkisi: Tek Kör Randomize Kontrollü Çalışma

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ÖZ

Amaç: İnme, fonksiyonel, bilişsel ve psikolojik sorunlar nedeniyle engelliliğin en yaygın nedenlerinden biridir. Etkilenen üst ekstremitedeki motor kusurlar, inme geçirenlerin yaklaşık %50'sini etkiler. Çalışmanın amacı modifiye Zorunlu Kullanım Tedavisinin (mZKT) hemiparetik sağ/sol üst ekstremite fonksiyonları ve yaşam kalitesi (QOL) üzerindeki etkilerini değerlendirmektir.
Araçlar ve Yöntem: Bu prospektif, randomize, kontrollü ve tek kör çalışmada, 40 hasta sağ-mZKT (n=10), sol-mZKT (n=10) ve kontrol (n=20) olarak gruplanmıştır. mZKT 4 saat/gün, 2 hafta, 10 seans uygulanmıştır. Tüm hastalara konvansiyonel rehabilitasyon programı uygulanmıştır. Hastalar Fugl-Meyer Motor Skala (FMS), Motor Aktivite Günlüğü (MAG), İnme etki ölçeği (İEÖ), Kutu Blok Testi (KBT), şekillendirme egzersizlerindeki tekrar sayısı ve görev egzersiz süresi kullanılarak değerlendirilmıştır.
Bulgular: Sol mZKT grubunun FMS'sında istatistiksel olarak anlamlı bir iyileşme saptanmıştır (p=0.040). Her iki mZKT grubu, MAG kullanım miktarında ve MAL kullanım kalitesinde, şekillendirme egzersizlerinin tekrar sayısında ve KBT'de ($p<0.05$) istatistiksel olarak anlamlı gelişmeler göstermiştir. İEÖ'nün günlük yaşam aktivitesi, el fonksiyonu ve inme iyileşme alanları her iki grupta da anlamlı olarak artmıştır ($p<0.01$). Sol-ZKT grubunda İEÖ'nün kuvvet alanında istatistiksel olarak anlamlı bir artış saptanmıştır (p=0.037).
Sonuç: mZKT, sağ/sol kol parezisi olan hastalarda motor fonksiyonları, el becerisini ve yaşam kalitesini iyileştirmede etkili saptanmıştır. Bu olumlu etkiler üç aya kadar devam etmiştir. mZKT' nin sol üst ekstremitede kol motor bozukluğu üzerinde olumlu bir etkisi olmasına rağmen, daha fazla araştırmaya ihtiyaç vardır.

Anahtar Kelimeler: inme; rehabilitasyon; üst ekstremite; yaşam kalitesi; zorunlu kullanım tedavisi

ABSTRACT

Purpose: Stroke is one of the most common causes of disability because of functional, cognitive, and psychological issues. Motor deficits in the afflicted upper extremity affect about 50% of stroke survivors. This study aimed to evaluate the effects of modified constraint-induced movement therapy (mCIMT) on hemiparetic right/left upper limb functions and quality of life (QOL).
Materials and Methods: In this prospective, randomized, controlled and single-blind study, 40 patients were assigned to the right-mCIMT (n=10), left-mCIMT (n=10), and control (n=20). mCIMT was applied 4h/day, 2 weeks, 10 sessions. A conventional rehabilitation program was applied to all patients. Patients were evaluated using the Fugl-Meyer Motor Assessment (FMA), Motor Activity Log (MAL), Stroke Impact Scale (SIS), Box-Block Test (BBT), the number of repetitions in shaping exercises, and the duration of task exercise.
Results: There was a statistically significant improvement in the FMA of the left-mCIMT group (p=0.040). Both mCIMT groups showed statistically significant improvements in the MAL-amount of use (AoU) and MAL-quality of use (QoU), the number of repetitions in the shaping exercises, and the BBT ($p<0.05$). The activity of daily living, hand function, and stroke recovery domains of the SIS were increased significantly in both groups ($p<0.01$). There was a statistically significant increase in the strength domain of the SIS in the left-CIMT group (p=0.037).
Conclusions: mCIMT was effective in improving motor functions, dexterity, and QOL in patients with right/left arm paresis. These positive effects continued for 3 months. Although left mCIMT had a positive effect on arm motor impairment, further research is needed.

Keywords: constraint-induced movement therapy; rehabilitation; stroke; upper limb; quality of life

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INTRODUCTION

Stroke is one of the most common causes of disability, resulting in functional, cognitive, and psychosocial issues.[1] After a stroke, around half of stroke survivors experience motor deficits in the affected upper limb that limit their ability to do daily tasks like eating, dressing, and grooming.[2] Health-related quality of life (HRQoL) impairments are linked to decreased engagement in social activities.[3] In this regard, strengthening upper limb functions, as well as boosting involvement in everyday activities, has become a major priority for stroke patients. In stroke patients, several rehabilitation strategies are used to improve motor performance and functional use of the afflicted upper limb. Neurodevelopmental facilitation techniques, strengthening and stretching exercises, music therapy, mirror therapy, mental practice and movement observation, electrical stimulation methods, non-invasive brain stimulation methods, robotic therapy, virtual reality, drugs that stimulate motor recovery, and constraint-induced movement therapy (CIMT) were all used to improve upper limb motor function after stroke.[4]

CIMT has emerged as a promising strategy among several techniques for stroke survivors. Taub et al. defined CIMT as a treatment based on the forced usage and intense training of the afflicted arm while restricting the unaffected arm.[5] For two weeks, CIMT consists of shaping and task-oriented activities that encourage the use of the damaged limb for 90% of waking hours.[6] Due to the complexity of administration, the original CIMT was updated. Modified CIMT (mCIMT) attempts to improve the patient's real-life use of the afflicted limb by improving the behavioral approaches used in conjunction with mCIMT. Treatment sessions for mCIMT range from 30 minutes to 6 hours per day for 2 to 12 weeks.[6,7]

Although various research has evaluated the efficacy of mCIMT on upper extremity functions of stroke patients with right/left hemisphere damage, few studies have investigated the efficacy of CIMT on motor functions in patients with stroke.[8,9] While extensive data have been developed to support the use of mCIMT, questions about the best treatment protocol, time after a stroke, therapeutic dose, and the impact of phenotypic variables on the effects of mCIMT on stroke outcome remain unresolved.[7] Furthermore, more research is needed to look into the probable impacts of mCIMT on HRQoL.[10-13]

In light of these findings, we conducted a study to see how mCIMT affected arm motor impairment, perceived upper limb motor function, dexterity, and HRQoL in patients with right/left hemiparesis following a stroke. We also looked into whether the efficiency of mCIMT differed between right and left hemiparesis individuals.

MATERIALS and METHODS

In this single-blind, randomized, and controlled interventional trial, 287 consecutive patients who were referred to our rehabilitation outpatient clinic were recruited. Of these patients, 40 with stroke who met the inclusion and exclusion criteria were included in the study. The study was carried out in the Department of Physical Medicine and Rehabilitation of the Istanbul University Istanbul Medical Faculty between January 2018 and December 2019. This trial was approved by the Istanbul University Istanbul Medical Faculty Clinical Research Ethics Committee in accordance with the Declaration of Helsinki and the study protocol (dated 10.11.2017, number 1278) and registered on ClinicalTrials.gov (NCT04013750). Written informed consent was obtained from all participants before enrollment.

The inclusion criteria are described as follows: participants over 18 years of age who were diagnosed with hemiplegia due to ischemic or hemorrhagic stroke (onset time greater than 20 weeks), ability to perform at least 20° of active wrist extension and at least 10° of active extension of each metacarpophalangeal and interphalangeal joint of all digits and these movements had to be repeated 3 times in 1 minute[14] no severe spasticity (modified Ashworth's scale<3), and absence of cognitive impairment (Mini-Mental State Examination score more than 20). Participants had to be able to walk and demonstrate postural stability while wearing a restraint. Exclusion criteria were bilateral stroke or multiple stroke history, severe shoulder or upper extremity pain, neglect on the hemiplegic side, global aphasia or cognitive disorders that may affect the participant's understanding of test instructions, presence of severe medical problems affecting the therapy and joint limitation of the affected arm.

The patients who met the inclusion criteria comprised 20 patients with right hemiplegia and 20 patients with left hemiplegia, according to the order of admission. These patients were randomized with the computer-generated random numbers by an independent blinded researcher as left mCIMT group (n=10), left control group (n=10), right mCIMT group (n=10), and right control group (n=10). However, statistical analysis was performed by combining patients in both the right and left control groups into a single control group. In the left mCIMT group, 10 stroke patients with left hemiplegia were included in the mCIMT program in combination with conventional rehabilitation, and in the right mCIMT group, 10 stroke patients with right hemiplegia were included in the mCIMT program in combination with conventional rehabilitation. In the control group, a total of 20 patients (10 patients with right stroke and 10 patients with left stroke) were included. The Consolidated Standards of Reporting Trials flow diagram is presented in Figure 1, including the withdrawal/drop-out reasons for the randomized groups.

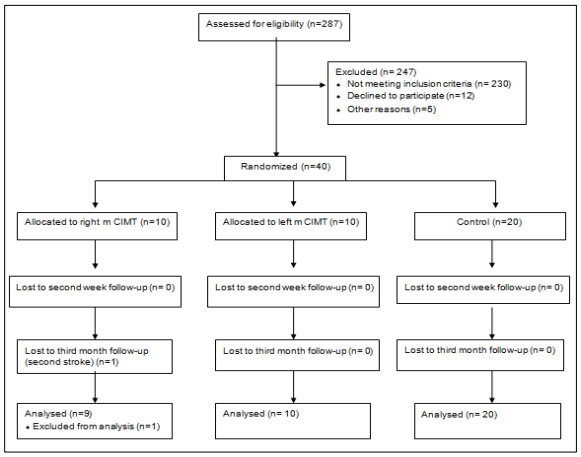

Figure 1. Flowchart of the participants through the study.

Interventions

mCIMT was applied to the right and left mCIMT groups 5 times per week, once per day, for 10 sessions at the Department of Physical Medicine and Rehabilitation. Each mCIMT session began with a 1-hour initial training program performed under the supervision of the investigator (C.M.) in groups of four, followed by a 3-hour home-based exercise program. The investigator instructed the participants on how to perform the home-based mCIMT exercises at the beginning of the study. The non-professional coach (family member or professional non-medical caregiver) was advised to maintain a training diary to document the number of repetitions and the time of practicing. Restriction with gloves that restrict all the fingers and the wrist and prevent grasping was applied to the unaffected upper extremity in 50% of the participants' waking hours. The participants were instructed to wear gloves outside therapy during their activities of daily living except when toileting, bathing and engaging in activities with a potential risk of fall.

The mCIMT training sessions comprised 3 components: limiting the unaffected upper extremity, repetitive task-oriented training (shaping and task activities), and developing behavioral methods that increase participation in daily activities. The shaping exercises included cube stacking, card turning, throwing balls into a box, grasping/holding and placing objects of different sizes, and drawing and painting exercises. The task exercises included activities of filling a glass, drinking a glass of water, and eating with a spoon. Verbal feedback was provided to the participants during the task and shaping exercises. The exercise program was planned with increasing difficulty according to the patients' performance and ability to achieve more complex levels of performance. When the patient exhibited a new movement, it was shaped by demanding more power, fluidity, accuracy, or functional versatility.

All patients were recommended to perform a conventional rehabilitation program. The conventional rehabilitation program consisted of upper-limb range of motion exercises, positioning, stretching, and strengthening exercises, fine motor exercises, balance exercises, and mobility training. The conventional rehabilitation program was demonstrated to all patients by an experienced physiotherapist at the clinic. All patients were asked to perform this program 30 minutes per day, 5 days per week, as a home-based exercise program. Conventional rehabilitation program adherence was encouraged and assessed during weekly telephone call reminders for all participants. The left and right mCIMT groups participated in an mCIMT program in addition to the conventional rehabilitation program.

Outcome Measures

The participants' demographic and clinical features were documented. The upper extremity Brunnstrom stages and Functional Independence Measure (FIM) were assessed to determine their functional status at the beginning of the study. The Fugl-Meyer Motor Assessment (FMA) of the upper extremity was the study's primary outcome measure. The Motor Activity Log (MAL) and the Box-Block Test (BBT), the number of repetitions of the shaping exercises such as stacking cube, turning card, grasping objects in 30 seconds, the duration of task exercise such as carrying a glass of water, and the Stroke Impact Scale (SIS) were secondary outcome measures. The patients were evaluated at the baseline (within 1-3 days before the inclusion), at 2 weeks (within a few days after the interventions were completed), and at 3 months using the outcome measures. The data assessor was blinded to the group status.

Brunnstrom is a scale that evaluates movement patterns and motor functions in stroke patients classified according to the stages of motor recovery. With this staging, the development of the patient can be followed. There are a total of 6 stages evaluating the motor development of the upper extremity, lower extremity, and hand.[15]

FIM, which was designed to evaluate the physical and cognitive disabilities of rehabilitation patients, differs from other scales in that it also evaluates cognitive functions. It consists of a total of 18 items evaluating 6 functional areas. The maximum score is 128, and the minimum is 18.[16]

Motor functioning, joint range of motion, sensory functioning and balance are the five domains of the FMA. The motor domain of the FMA includes items assessing movement, coordination, and reflex action of the upper extremity. Each item is given a score ranging from 0 to 2 based on how well it can be performed.[17] The FMA's upper extremity score ranges from 0 to 66, with higher scores indicating improved motor function.[18]

The researchers who created mCIMT developed MAL-28 to measure the frequency and quality of actual use of the affected arm, taking into account the inadequacies of previous scales.[19] MAL-28 is made up of two scales that assess how often the affected arm is utilized for each activity over the course of 28 days [amount of use (AoU)] and, if so, how well the patient can use the affected arm [quality of use (QoU)] (QoU). These scales ranged from 0 to 5. To obtain the average score, the total scores of both scales are calculated separately and divided by the number of questions. Higher scores indicate a high AoU and the quality of the more affected arm's movements in daily activities.[19,20]

The BBT is a quick, easy, and inexpensive test that can be used to assess one-sided dexterity in a number of conditions, including stroke patients. The BBT consists of a box divided into 2, and 150 blocks. The wooden blocks consist of 2.5 cm×2.5 cm×2.5 cm cubes. The length of the barrier in the middle of the box is 15.2 cm. The patients were asked to transfer individual blocks from one section to the other section within 60 seconds, and the number of blocks was recorded.[21]

The SIS 3.0 is a 59-item self-reported questionnaire designed to assess HRQoL in stroke patients. Strength, memory, mood, communication, activities of daily living, mobility, hand function, and participation are the eight subscales that make up the SIS. Each question is graded on a 5-point scale based on how difficult it was the previous week. Each domain's score ranges from 0 to 100, with higher values indicating greater HRQoL. A question on the SIS assesses the patient's overall perception of recovery using a visual analog scale ranging from 0 to 100 points, with 0 representing no recovery and 100 representing complete recovery.[22]

Statistical Analysis

G*Power version 3.1.9.2 (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) was used for statistical analysis, study power analysis, and sample size calculation to provide a sufficient sample size for the one-way analysis of variance (ANOVA) test.[13] The sample size was determined using predicted differences and standard deviations (SDs) from a prior study (effect size of 0.42).[13] The ideal sample size for each group in this study was n=9 to achieve a power of 0.95 [(Type I error) was 0.05 and (Type II error) was 0.05; three intervention groups

with three repetitions]. A total of 40 stroke patients were enrolled in the trial, assuming a 10% drop-out rate.

All data were statistically analyzed using the SPSS 21.0 program (Statistical Package for the Social Sciences, Chicago, IL, USA). The homogeneity between groups was first determined using ANOVA, Chi-square test, and Kruskal-Wallis variance analysis. To acquire paired measures for an intragroup comparison of pre-treatment, post-treatment, and post-treatment values at 3 months, the Wilcoxon Signed Ranks test and Friedman test were used. The difference in values obtained before and after treatment (post-test-pre-test) was calculated, and the Kruskal-Wallis test was employed to compare the groups.

The Wilcoxon Signed Ranks test and the Friedman test were employed in the subgroup analysis to produce paired data for a comparison of pre-treatment, post-treatment, and post-treatment 3 months within-group values. Using Bonferroni correction, the significance level for the multiple comparison test was set at 0.017 (p-value=0.05/number of pair-wise comparisons). The difference in values obtained before and after treatment (post-test-pre-test) was determined, and the Mann-Whitney U test was used to compare the two groups. The significance level in all evaluations was $p<0.05$.

Findings

The study enrolled a total of 40 participants. A subsequent stroke occurred during the 3-month follow-up period following treatment; hence one patient in the left mCIMT group was eliminated from the study. The statistical analysis did not include this participant. In terms of demographic and clinical features, there was no significant difference between the three groups ($p>0.05$), as indicated in Table 1. The left mCIMT group had 87 percent compliance with the usual rehabilitation program, 85 percent for the right mCIMT group, and 83 percent for the control group. In terms of adherence rates, there was no significant difference between the three groups ($p>0.05$).

Table 1. Homogeneity of demographic and clinical variables between three groups at baseline.

Variables		R (n=9)	L (n=10)	C (n=20)	p
Age (years)	Mean ± SD	52.4±14.61	62.2±9.89	56±14.85	0.281†††
	Median (min-max)	55 (18-67)	65 (43-78)	58 (25-80)	
Duration of stroke	Mean ± SD	25.20±13.01	33.78±27.49	32.15±21.40	0.912††
(months)	Median (min-max)	28 (5-41)	24 (7-80)	27.5 (6-79)	
		n (%)	**n (%)**	**n (%)**	
Sex	Female	3 (30)	4 (40)	5 (25)	0.706†††
	Male	7 (70)	6 (60)	15 (75)	
Marital status	Single	4 (40)	4 (40)	6 (30)	0.807†††
	Married	6 (60)	6 (60)	14 (70)	
Education level	Primary school	3 (30)	5 (50)	8 (40)	0.249††
	Junior high school	5 (50)	1 (10)	2 (10)	
	High school	2 (20)	1 (10)	4 (20)	
	University	0 (0)	1 (10)	5 (25)	
Dominant hand	Right	10 (100)	8 (80)	19 (95)	0.206†††
	Left	0 (0)	2 (20)	1 (5)	
Type of stroke	Ischemic	6 (60)	8 (80)	17 (85)	0.187†††
	Hemorrhagic	4 (40)	2 (20)	3 (15)	
Brunnstrom stage	Mean ± SD	5.4±0.84	4.8±1.0	5.4±0.6	0.186††
Arm	Median (min-max)	6 (4-6)	5 (3-6)	5.50 (4-6)	
Brunnstrom stage	Mean ± SD	5.5±0.70	4.7±0.94	5.3±0.67	0.079††
Hand	Median (min-max)	6 (4-6)	5 (3-6)	5 (4-6)	
FIM	Mean ± SD	116.6±18.1	110.1±24.63	114.5±17.39	0.682††
	Median (min-max)	124.50 (68-126)	124.50 (59-125)	122.50 (67-126)	

R, Right Hemiplegia Group; L, Left Hemiplegia Group; C, Control Group; SD, Standard Deviation; FIM, Functional Independence Measure.
† ANOVA test ($\alpha = 0.05$).
†† Kruskal-Wallis test ($\alpha = 0.05$).
††† Chi-Squared test ($\alpha = 0.05$).

In terms of all outcome measures, there was no significant difference in the baseline assessment between the three groups ($p>0.05$), as described in Table 2. At two weeks ($p=0.009$) and three months ($p=0.002$), there was a statistically significant improvement in the upper extremity scores of the FMA in the left-mCIMT group compared to the control group. During the three months, however, there was no significant difference between the right mCIMT group and the control group in terms of upper extremity FMA scores.

The duration of carrying a glass of water at the end of 2 weeks ($p<0.001$) and the number of repetitions of stacking cubes at 3 months ($p=0.014$) significantly improved only in the left mCIMT group compared to the control group. The MAL-AoU; MAL-QoU; the number of repetitions of the shaping exercises, such as turning cards and grasping objects; and BBT scores were improved significantly in both the right-mCIMT group and left-mCIMT group at the end of the treatment and during the 3-month follow-up period ($p<0.05$). At 2 weeks ($p=0.012$) and 3 months ($p=0.000$), the left CIMT group had a statistically significant increase in the strength domain of the SIS compared to the control group. Memory, emotion, communication, mobility, and participation domains of the SIS were not statistically different ($p>0.05$); however, the activity of daily living, hand function, and stroke recovery domains of the SIS were significantly increased in both groups ($p<0.01$) over a 3-month period compared to the control group.

Table.3 summarizes the changes in the outcome measure values among the three groups from the baseline to the second week and third month.

Table 2. Homogeneity of outcome variables between three groups at baseline.

Variables		R (n=9)	L (n=10)	C (n=20)	P
FMA (upper extremity)	Mean ± SD	63.60±14.80	49.50±15.02	55.40±11.96	0.121†
	Median (min-max)	65 (35-66)	51 (31-66)	60 (22-66)	
MAL (AoU)	Mean ± SD	3.91±1.26	2.87±1.37	3.68±1.12	0.143†
	Median (min-max)	4.10 (0.64-4.93)	2.87 (0.64-4.54)	4.12 (1.32-4.96)	
MAL (QoU)	Mean ± SD	3.84±1.24	2.82±1.36	3.60±1.09	0.133†
	Median (min-max)	4.05 (0.64-4.86)	2.83 (0.64-4.54)	3.95 (1.29-4.84)	
Box-block test	Mean ± SD	28.8±12.44	21.77±13.17	25.10±13.36	0.467†
	Median (min-max)	27 (10-48)	20 (7-42)	22 (2-46)	
Stacking cube	Mean ± SD	9.8±4.61	6.8±4.07	9.0±4.15	0.264††
	Median (min-max)	9.5 (2-20)	6 (1-14)	8.5 (2-18)	
Turning card	Mean ± SD	11.6±6.29	8.1±4.14	11.10±4.40	0.26†††
	Median (min-max)	10 (4-26)	7 (2-14)	11 (4-22)	
Grasping objects	Mean ± SD	14.1±6.78	9.3±4.34	12.55±5.71	0.167††
	Median (min-max)	13.5 (5-30)	8.5 (4-16)	13.5 (2-27)	
Carrying a glass of water	Mean ± SD	5.05±3.08	13.15±12.80	5.69±4.11	0.198†
	Median (min-max)	3.7 (2.20-12.00)	8.8 (2.80-43.00)	4.1 (2.15-20.83)	
SIS total	Mean ± SD	81.88±11.30	74.0±10.6	75.07±14.46	0.215†
	Median (min-max)	83.91 (54.05-95.23)	73.36 (51.68-89.01)	76.42 (49.39-95.31)	

R, Right Hemiplegia Group; L, Left Hemiplegia Group; C, Control Group; SD, Standard Deviation.
FMA, Fugl-Meyer Assessment; MAL, Motor Activity Log; AOU, Amount of Use; QoU, Quality of Use; SIS, Stroke Impact Scale
† Kruskal-Wallis's test ($\alpha = 0.05$). †† ANOVA test ($\alpha = 0.05$).

DISCUSSION

The study found that using the right and left mCIMT in combination with traditional rehabilitation improved upper extremity motor function, dexterity, and quality of life when compared to conventional rehabilitation alone. Similarly, when compared to active rehabilitation techniques, Corbetta et al. found that CIMT was related to improvements in arm motor impairment and perceived motor function.[23]

Over a 3-month period, our research found that left mCIMT was more effective than the control group in lowering arm motor impairment as indicated by the FMA. However, there was no further effect of right mCIMT on upper limb disability. In comparison to conventional rehabilitation, only left mCIMT enhanced the time of carrying a glass of water after two weeks and the number of repetitions of stacking cubes after three months. The spontaneous use of the left upper limb, either by reducing trained non-use or by overcoming the dominance of the right upper limb in daily tasks, may explain these favorable benefits of left mCIMT.

Furthermore, functional magnetic resonance imaging (MRI) changes were assessed in individuals with right or left hemisphere damage to better understand the interhemispheric interactions that emerged during afflicted limb movement with and without contralateral restriction.[24] Vidal et al. found that right-hemispheric stroke patients had bilateral sensorimotor cortex activation, whereas left-hemispheric stroke patients had only unilateral dominance.[24] However, clinical data on the effects of CIMT in various hemisphere lesions are scarce. Sterr et al. observed that 2-week mCIMT was helpful in increasing motor ability assessments such as the Wolf Motor Func-

tion Test and the MAL in patients with left and right hemiparesis, with no differences found between the two.[9]

In our study, there was no significant difference between the right and left mCIMT groups on any of the outcome measures. However, it should be noted that the higher FMA baseline values in the right mCIMT group may have influenced our findings.

When used in conjunction with traditional physical treatment, mCIMT has been demonstrated to improve perceived arm motor function in terms of the AoU and QoU of the paretic arm. These findings demonstrated that mCIMT could reduce the learned non-use phenomena seen in stroke patients.[25]

Previous research has demonstrated that CIMT increased the perceived arm motor function of the paretic arm based on the MAL, which supports our findings.[11,13,26] Patients who received mCIMT showed considerably larger improvements in task-oriented activity repetitions and dexterity as judged by the BBT than those who received traditional rehabilitation. A small number of research looked at how mCIMT affected task-oriented activities. Treger et al. observed that throughout a subacute rehabilitation period, mCIMT had considerably greater changes in the number of repetitions for each task, which included pegs transfer, ball gripping, and eating with a spoon, compared to the normal therapy group.[12]

However, task-oriented activities should be seen as part of the functional tasks that were implemented in our intervention group via shaping exercises. Furthermore, some randomized-controlled investigations examined the effects of CIMT and traditional therapy on dexterity and found significant differences between the groups using various outcome measures, such as the Perdue Pegboard test or the Nine-hole Peg Test.[27,28] However, it's unclear whether the gains in dexterity are due to a decrease in basic motor dysfunction or the acquisition of compensatory movement methods.[29]

In the SIS domains of activities of daily living, hand function, and recuperation, there was statistically significant improvement with right and left mCIMT, but not in memory, emotion, communication, mobility, or involvement. At three months, the left mCIMT group scored higher in the strength domain than the conventional rehabilitation group, which could be due to an increase in arm and handgrip strength. These good effects of mCIMT were largely seen in physical domains, such as activities of daily living or hand function, which is partially compatible with our study's increase in motor function.

mCIMT was helpful for enhancing the strength, activities of daily living, and stroke recovery domains of the SIS, according to Wu et al.[30] Dettmers et al. found that physical function increased significantly from pre- to post-treatment and that this improvement was maintained during a 6-month follow-up period.[31] However, the authors discovered that from pre-treatment to the 6-month follow-up period, participants improved in social participation and communication subscales.[31] The lack of significance in other SIS areas, such as involvement, could be due to the short follow-up time, which may not be long enough to accurately assess mCIMT's long-term impacts.

In studies of mCIMT in stroke survivors, the number of hours of restraint of the unaffected arm per day, time of exercise with the affected arm, treatment length, and type of exercises used varied.[11-13,26,30] As a result, there is no consensus on the most effective time for constraint, how long the treatment should last, or which exercise routines should be used. In our study, mCIMT was given in ten sessions over five days per week for two weeks; the affected arm was exercised for 20 hours per week, and the unaffected arm was restricted for 50% of the patient's waking hours. Some studies recorded over 30 hours of task practice with the afflicted arm in some cases.[28,32] A systematic review, on the other hand, found no significant difference in upper limb function between longer and shorter exercises.[23]

In our study, mCIMT combined with traditional therapy increased motor function and dexterity at the end of treatment, and the improvement lasted for a maximum of three months. Based on these data, we believe that the long-term effects of mCIMT are possible due to the likelihood of continued motor relearning after therapy. The Extremity Constraint Induced Movement Therapy Evaluation (EXCITE) experiment found that a 2-week

CIMT intervention improved the motor function and hand functions domain of the SIS after intervention and 12 months in patients who had a stroke between 3 and 9 months.[33]

We were able to compare the results of mCIMT combined with traditional rehabilitation to conventional rehabilitation alone in patients with right and left hemiplegia in this prospective, randomized, controlled, single-blind trial. Although numerous studies have compared the efficacy of mCIMT in patients with right or left hemisphere damage using various outcome measures such as upper extremity motor impairment, motor function, dexterity, and quality of life in a randomized controlled design, none have done so in patients with right or left hemisphere damage. However, whether mCIMT can substitute other therapies for enhancing arm motor function is currently unknown.

The length of a stroke could be a key factor in determining the impact of mCIMT on upper-extremity dysfunction. The majority of studies examining the effects of mCIMT were conducted in patients with a time since stroke of 0 to 3 months, and the use of mCIMT in cerebrovascular stroke rehabilitation during the acute stage is strongly recommended.[23, 34] Furthermore, the data on early versus late mCIMT appears to be contradictory.[26,35,36] However, phenotypic characteristics such as gender, age, or type of stroke, as well as time after stroke, have been shown to have no statistically significant effect on the efficiency of mCIMT after stroke.[7,23]

In our research, strokes lasted anywhere from 5 to 80 months. The number of participants with an onset time of less than 12 months was similar in all three groups, and the difference in mean onset time was not significant.

Our findings suggested that mCIMT may improve arm functions and dexterity in stroke patients more effectively than traditional rehabilitation methods, even when the intervention was started more than 12 months after the stroke. As a result, the favorable effects seen in mCIMT cannot be explained by the confounding effect of natural stroke recovery. Similarly, Kitago et al. stated that functional improvement in the afflicted arm following CIMT in chronic stroke patients seemed to be mediated by compensatory mechanisms rather than a recovery of deficiencies.[37] It's also worth emphasizing that we only included higher-functioning people in our research.[14]

One of the limitations of the study is that the long-term effect of our treatment cannot be adequately evaluated since the follow-up period of the mCIMT program we used was three months. In addition, the lack of a certain standardization in the mCIMT protocol is among the limitations of this study. In addition, although the sample size was calculated, the number of patients is small.

Conclusion

In patients with right and left hemisphere injuries, mCIMT combined with traditional rehabilitation led to better improvements in motor function, dexterity, and quality of life than conventional rehabilitation alone. Over a 3-month timeframe, left mCIMT had a beneficial effect on arm motor deficits as compared to standard rehabilitation. More research with a larger sample size and a longer follow-up time is needed to determine the efficacy of mCIMT for patients with left and right arm paresis.

Conflict of Interest

The authors declare that there is not any conflict of interest regarding the publication of this manuscript.

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Ethics Committee Permission

Approved by Istanbul University Istanbul Medical Faculty Clinical Research Ethics Committee (10.11.2017 dated and 1278 number).

Authors' Contributions

Concept/Design: CMC, EİŞ, TK, AY. Data Collection and/or Processing: CMC, TK, TŞ. Data analysis and interpretation: CMC, TK, TŞ. Literature Search: CMC, EİŞ, AY. Drafting manuscript: CMC, TŞ. Critical revision of manuscript: EİŞ, AY. Supervisor: AY.

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