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Effects of a Collective Intervention through Constraint-Induced Movement Therapy in the Recovery of Upper Extremity Function Affected by a Stroke in Daily Activities: A Single-Blind Randomized Parallel Trial

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Abstract

Background: Constraint-induced movement therapy (CIMT) is a treatment strategy that has been shown to improve the function of an upper limb affected by stroke. Although an extensive corpus of literature supports the positive impact of CIMT on neuroplasticity and the recovery of function, has evaluated CIMT conducted individually. Evidence is limited for the application of a CIMT in a collective modality and investigation is needed.

Objective: To determine the effectiveness of a modified version of CIMT as a part of combined or collective treatment, as compared to individual CIMT, in increasing the use and functionality of movement of a paretic upper limb.

Methods and subjects: The study was a single-blind, randomized parallel trial. Thirty-six patients who had had a stroke for up to 6 months were randomly divided into two intervention groups. The independent variable was the implementation of collective or individual therapy for 3 h for 10 consecutive days and the dependent variables were amount of use and dexterity of the affected upper extremity in activities of daily life. Dependent variables were evaluated by the Motor Activity Log (MAL) and Action Research Arm test (ARAT), at baseline (pre-intervention evaluation), end (post-intervention evaluation) and six months after intervention (follow-up).

Results: By controlling the pre-intervention evaluations, analyses of covariance indicated that both dependent variables presented significant differences and the results were in favor of the group therapy at both the post-intervention evaluation and follow-up evaluations.

Conclusion: Both types of intervention generated increases in the function and use of the upper extremity, with these increases being higher in the collective modality. The effects of the collective modality were maintained 6 months after the intervention ended.

Keywords: Constraint induced movement therapy; Functionality; Stroke; Upper extremity

Abbreviations: CIMT: Constraint-Induced Movement Therapy; MAL: Motor Activity Log; ARAT: Action Research Arm Test; ADL: Activities of Daily Living; HUE: Hemi-Paretic Upper Extremity; AOU: Amount of Use; QOM: Quality of Movement

Introduction

Strokes causes a high degree of disability [1], negatively affecting different areas of physical and social function [2] and leads to an inherent need for rehabilitation.

Constraint Induced Movement Therapy (CIMT) is a behavioral technique that is based on reversing learned non-use [3] to improve functional use of the upper extremity after a stroke. Of patients with this disease, 55% to 75% have functional limitations in their superior [4] limbs, affecting their participation in activities of daily living (ADL) [5], having a direct impact on their quality of life [6]. Thus, the recovery of function, referred to as the sensory-motor ability of the extremity to make the necessary movements to enable optimal performance of ADLs [7], is fundamental because of its importance in different fields of life.

The benefits of original therapy protocols in individual modes has been investigated widely [8,9], showing improvements in the use of upper extremities in the real world, through the execution of exercises that simulate functional tasks that are directly related to the demands of daily life. Its application and result scopes in clinical settings is still limited due to technical demands, human resources, clinical resources, restriction schedules and cultural realities [10].

The purpose is to determine whether a modified version of CIMT, through its application in a collective mode and for 3 h, improves function and use of the upper extremity; this, considering the benefits of collective work, referring to that experience and information sources multiply, opens a wide margin for the exchange of ideas and emotional [11] support by encouraging the rehabilitation [12] process.

Method

Design overview

This study used a single blind, randomized, clinical trial design, with two parallel intervention groups (collective or individual) and three assessment points (pre-test, post-test and follow-up).

Setting and subjects

We identified 120 users belonging to the Temuco (Chile) community

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rehabilitation centre; of these 76 did not meet the inclusion criteria and 8 did not agree to take part, leaving a sample consisting of 36 users. They signed an informed consent and the trial was authorised by the Ethics Committee of Universidad de La Frontera (Figure 1).

There were nine inclusion criteria: age range between 30 and 80 years, presenting a unique stroke confirmed by computerized tomography, with a greater evolution period than 6 months [13], ability to sit independently, obtaining between 5 and 14 points on the NIHSS scale, <2 points on the Modified Ashworth Scale, <4 points on the visual analog scale and being able to perform a functional test of 20° wrist extension and 10° finger extension [14]. Subjects presenting sensory compromises (visual-auditory) and orthopedic limitations (use of cane) were excluded.

Table 1 summarizes the demographic and clinical characteristics of the two groups (subjects who received the collective modality therapy and participant who received the standard individual therapy). The groups were equivalent in all of these characteristics, except on sex where the collective modality group included relatively more men than women (75% versus 25%) and the individual modality group included the reverse sex pattern (33% versus 67%).

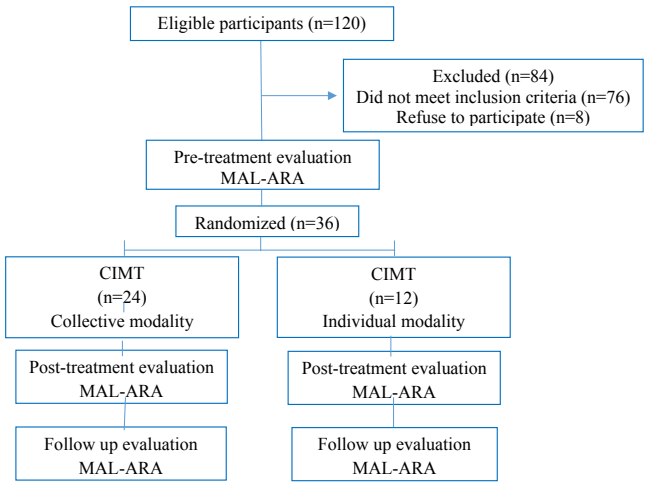

Figure 1: Diagram showing recruitment and allocation of participants. All stroke patients admitted to the Rehabilitation Center of Temuco, Chile in the period from March 2014 to June 2014.

Variable	Modality		Statistical test
	Collective	Individual	
Sex, *f*			
Male	18	4	$\chi^2(1)=5.84^{**}$
Female	6	8	
Type of stroke, *f*			
Intracerebral	3	4	
Non specific intracerebral	0	1	
Intracranial	3	0	
Pre-cerebral occlusion and stenosis	3	2	$\chi^2(6)=7.14$
Cerebral occlusion	12	4	
Acute stroke	2	0	
Indefinite stroke	1	1	
Dominant side affected, *f*			
Yes	9	6	$\chi^2(1)=0.51$
No	15	6	
Age, *M* (*SD*)	58.33 (10.38)	48.75 (18.60)	*F* (1, 34)=0.51
Spasticity, *M* (*SD*)	1.04 (0.46)	1.08 (0.52)	*F* (1, 34)=0.06
Pain, *M* (*SD*)	1.46 (0.51)	1.25 (0.45)	*F* (1, 34)=1.44
Evolution, *M* (*SD*)	25.63 (23.52)	39.00 (33.51)	*F* (1, 34)=1.94
Mini Mental, *M* (*SD*)	16.58 (1.53)	16.75 (2.01)	*F* (1, 34)=0.07

f: frequency; M: Mean; SD: Standard Deviation

Table 1: Sociodemographic and clinical characteristics of the participants.

Randomization and Interventions

Randomization was performed by randomly assigning a number from 1 to 6 to patients who met the inclusion criteria. Subjects receiving numbers between 1 and 4 were part of the collective group and patients receiving the numbers 5 and 6 were part of the individual intervention group.

The protocol was administered six times. On each occasion, four subjects were included from the collective group, working together in the same place and two subjects under the individual category, on a one-on-one basis, each working in separate and isolated enclosures. To match general intervention conditions (such as day and time), on each occasion both groups were treated in parallel.

The difference in the number of subjects exposed to each modality (n=24 and n=12) is due to two reasons. In the same period, the collective mode allows inclusion of a greater number of subjects than the individual mode. In addition, the methodological requirement to administer both modalities in parallel reduced the number of subjects exposed to the individual mode, because of the physical and human resources available.

Following randomization and one week before surgery, two trained unbiased evaluators performed a pre-treatment evaluation and subsequently under the same conditions, a post-treatment evaluation and follow-up (6 months) using the Motor Activity Log-30 (MAL-30) and Action Research Arm Test (ARAT) (Figure 1).

The intervention protocol was applied in both groups for 3 h daily for 10 days by an expert physical therapist and student assistants.

Applied protocols included three main elements [14] in both modalities

1. Repetitive training oriented at the task: during each session, patients performed repetitive exercises that mimic activities of daily life, oriented at training the affected upper extremity. Exercises were conducted using formation or shaping, behavioral technique aimed at increasing the amount and extent of limb use by performing motor tasks. To do this, 30 tasks were performed involving shoulder joints, elbows, wrists and hands. Each functional activity is practiced in ten sets of ten attempts for 60 to 120 s.

2. Induction to using the affected upper extremity: motor restriction of the unharmed upper extremity was conducted through the use of a glove, which eliminates the possibility of using the hand for most of the functional activities, especially when the physical therapist is not present. The goal was to use the glove 70% of day light hours, avoiding use in activities such as bathing and any activity that creates danger for the subject.

3. **Package transfer:** one of the intervention goals is to transfer patient achievements in therapy to the real world. To achieve this objective, a set of behavioral techniques called "transfer package" whose objective is that patients be responsible for their adherence to therapy requirements, ensuring that the

patient participate actively in the intervention, without the constant supervision of the physical therapist, a relevant matter in everyday life in which this professional might not present.

The standard procedure of a typical session is described below:

1. It begins when subjects enter the therapy location.
2. The Home Diary is then revised, document describing the tasks (with and without the glove) performed by patients at home during the time not in therapy, which forms part of the transfer package. In the collective mode, this activity was shared among subjects, giving them the opportunity to exchange information, give and receive feedback and generate problem-solving strategies.
3. Subsequently, subjects perform specific motor tasks. Six previously defined activities were performed which simulated activities of daily life, involving movements of shoulders, elbows, wrists and fingers. Each activity has its own requirements, parameters, progressions and objectives. In order to avoid fatigue, increased tone and demotivation, rest periods and stretches were implemented between each exercise. In the collective mode, these breaks allowed subjects to share experiences. Exercise uses the highest percentage of hours in therapy, approximately 70%.
4. Sessions were concluded by defining five Specific tasks to perform at home, using the glove, with the aim of promoting the use of the weak arm in off-site therapy.

Outcome Measures

We used the Chilean versions of the Motor Activity Log-30 (MAL-30) and the Action Research Arm Test (ARAT) to evaluate daily function and motor function. Both scales have shown good reliability and validity in Chile and other countries [15,16].

MAL-30 provides a measure of a patient's perception of real-world use of the hemi-paretic upper extremity (HUE) in 30 relevant daily activities. Patients are asked to rate how much (Amount of Use or AOU scale) and how well (Quality of Movement or QOM scale) their HUE was used to accomplish each of the activities, on a 5-point response scale. Following research recommendations, only AOU scores were included in this study [17]. AOU scores range from 0 to 5; higher scores indicate greater amount of HUE use [18].

ARAT assesses of the upper extremity motor functional limitations in different tasks involving grasp, grip, pinch, and gross movement. Each of its 19 items is rated from zero (never used) to three (the same as pre-stroke). Total scores range from zero to 57; higher scores indicate normal functional performance.

Scale administration was conducted according to the standardized procedures described in their respective testing manuals. Scales showed very good reliabilities in this study (Table 2).

Data Analysis

We performed analyses of covariance (ANCOVAs) to determine whether post-test and follow-up scores were significantly different between the two treatments groups, once pre-test scores were held constant. For each of the outcome variables, we conducted two one-way between-subject ANCOVAs. In the first analysis, we used the post-test scores as the dependent variable and the pre-test scores as the covariate. Group treatments (i.e., collective or individual CIMT was the independent variable. In the second analysis, to evaluate the stability of changes we repeated the ANCOVAs using, this time, the follow-up scores as the dependent variable and the pre-test scores as the covariate. Prior to ANCOVAs, the homogeneity-of-slope assumption was examined.

Results

Means and standard deviations of the dependent variables by treatment modality and measurement time are presented in Table 3.

Effects on amount of use. MAL mean scores increased from the pre-test to the post-test by 1.30 points for the collective CIMT group and by 1.18 points for the individual CIMT group. We conducted an ANCOVA to verify whether post-test scores differed significantly by treatment group when holding pre-test scores constant. A preliminary analysis assessing the homogeneity-of-slopes assumption revealed that the relationship between the covariate and the dependent variable did not differ significantly in each group, $F(1, 32)=0.180$, $p=0.674$. The ANCOVA indicated a significant difference between the treatment conditions favoring the collective intervention group, after controlling for the pre-test scores, $F(1, 31)=21.55$, $p<0.001$, $\eta^2p=0.57$.

The magnitude of MAL means showed scarce variation from the post-test to the follow-up for both groups. To assess the stability of the changes observed between pre-test and post-test, ANCOVA using the follow-up scores as the dependent variable and the pre-test scores as the covariate revealed a significant difference favoring the collective treatment group, $F(1, 31)=19.44$, $p=0.001$, $\eta^2p=0.54$. Previously, an examination of the homogeneity-of-slopes assumption showed that the relationship between the covariate and the dependent variable was not significantly different in each group, $F(1, 32)=0.510$, $p=0.480$.

Effects on motor function. ARAT mean scores increased from the pre-test to the post-test by 4.95 points for the collective CIMT group and by 4.94 points for the individual CIMT group. An ANCOVA indicated a significant difference between the treatment conditions favoring the collective intervention group, after controlling for the pre-test scores, $F(1, 31)=4,72$, $p=0.016$, $\eta^2p=0.22$. Previously, the homogeneity-of-slopes assumption was fulfilled, $F(1, 32)=2.068$, $p=0.160$.

Dependent variables and treatment groups	Pre-test	Post-test	Follow-up
Amount of use (MAL)			
Collective	0.93	0.92	0.93
Individual	0.94	0.96	0.95
Motor function (ARAT)			
Collective	0.96	0.96	0.97
Individual	0.98	0.98	0.98

Table 2: Internal consistency (Cronbach alpha) of dependent variables by treatment modality and time of measurement.

Dependent variables and treatment groups	Pre-test	Post-test	Follow-up
Amount of use (MAL)			
Collective	1.79 (0.95)	3.09 (0.89)	2.93 (0.86)
Individual	1.51 (0.99)	2.69 (0.88)	2.53 (0.87)
Motor function (ARAT)			
Collective	37.96 (13.07)	42.91(7.75)	42.37 (8.38)
Individual	35.25 (17.00)	40.19 (7.76)	40.60 (8.39)

Post-test and follow-up means and standard deviations are adjusted by their respective pre-test scores.

Table 3: Means (and standard deviations) of the dependent variables by treatment group and measurement time.

ARAT means showed small variation from the post-test to the follow-up for both treatment conditions. An ANCOVA with the follow-up scores as the dependent variable and the pre-test scores as the covariate revealed a significant difference in favor of the collective treatment group, $F(1, 31)=3.69.44$, $p=0.036$, $\eta^2p=0.18$. Again, the homogeneity-of-slopes supposition was previously fulfilled, $F(1, 32)=2.143$, $p=0.153$.

Discussion

The main findings of this study were that both forms of intervention CIMT, generate increases in function and use of upper extremities, these increases being higher in the collective mode, which remains in process even 6 months after the intervention.

From a functional point of view, subjects in the collective group improved quality and range of motor actions, performing complex tasks involving upper limb and shoulder movements on a functional level and pinch with less effort.

Improvements in motor task performance during work sessions were transferred to everyday life situations that were described by families, indicating that the benefits of motivation and function generated in the collective mode are easily transferred to real world patient activities, a fact also reported in other studies [19,20].

During the intervention was possible to observe that the collective mode motivate each other competitively. In addition, small improvements for a subject encourages others to work with more enthusiasm, especially when performing tasks which give results according to the number of repetitions or time spent in execution. It is valid to assume that this motivating dynamics of collective work, observed by the treating team and reflected in the results, has fostered a greater willingness to increase affected limb use in daily activities [13].

It is proposed that the collective mode strengthens basic human needs such as security, affection, sense of belonging and self-esteem [21]. A greater amount of information is also exchanged in the collective mode because experience and information sources multiply, which opens a wide scope for the exchange of ideas, feelings and other experiences [11]. Allowing the principal of universality in appreciating common problems, which helps individuals to focus less on themselves and at the same time feel challenged in their rehabilitation process.

Considering the above, it is important to note that given the nature of the intervention in the collective mode, for 3 h every day, benefits achieved were beyond just motor recovery, since patients generated emotional ties, shared experiences and were motivated during the course of the intervention.

It is important to consider the advantages of the collective mode in finding a balance between human, physical and financial resources, bearing in mind that 30% to 50% of costs associated to strokes are for rehabilitation [22].

Proposing a strategy with proven effectiveness, which allows for greater numbers of patients, would reduce substantial costs associated with rehabilitation, also supporting the decision-making process of public policies [23].

This balance between cost-effectiveness, would in turn rehabilitate a greater number of people, expand coverage, improve recovery times and transfer patient achievements to everyday activities.

Conclusion

Both types of interventions generate increases in weak upper limb function and use, these increases being higher in the collective mode. Collective mode advantages maintain for six months after the intervention.

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