Long-Term Follow-Up After Constraint-Induced Therapy: A Case Report of a Chronic Stroke Survivor

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OBJECTIVE. Upper-extremity functional improvements after constraint-induced movement therapy have not been documented beyond 2 years. This case report describes the long-term maintenance of the effects of change 4–5 years after an application of constraint-induced therapy.

METHOD. A 36-year-old female poststroke patient participated in constraint-induced therapy for 2 weeks. She was evaluated before and after treatment and again 4 and 5 years later. Primary outcome measures included the Wolf Motor Function Test, Stroke Impact Scale, and Motor Activity Log.

RESULTS. Improvements were maintained in reported use and ability of the arm and hand, time to complete functional tasks, and physical aspects of health-related quality of life. Fatigue may have had a moderating effect on the extent of these changes.

CONCLUSION. Improved upper-extremity function continued over a 5-year period after constraint-induced therapy; however, poststroke fatigue remained an influential limiting factor.


Recently, an innovative technique called constraint-induced therapy has shown promise for stroke survivors with mild to moderate hemiparesis. This intervention consists of restraint of the less-involved upper extremity (forcing use of the more-involved upper extremity) and massed practice of the more-involved upper extremity (Wolf, Blanton, Baer, Breshears, & Butler, 2002; Wolf et al., 2006). Evidence has supported the efficacy of constraint-induced therapy in improving arm function in acute (Dromerick, Edwards, & Hahn, 2000), subacute (Wolf et al., 2006), and chronic (Taub et al., 2006) stages after stroke. The maintenance of these improvements has been documented up to 2 years (Wolf et al., 2008) but not beyond this time period. To date, only one randomized clinical trial has evaluated the long-term effects of an intensive upper-extremity therapy on arm function after stroke (Feys et al., 2004). This study found significant improvements in impairment measures but not in activities of daily living (ADLs); no health-related quality of life (HRQOL) measurements were taken.

In this case report, we describe the long-term maintenance of improvements in impairments, function, and HRQOL associated with constraint-induced therapy in a patient with chronic stroke. A long-term follow-up evaluation of an intervention, such as constraint-induced therapy, allows for a more comprehensive picture of trends in stroke recovery and integration of physical and behavioral improvements in the stroke survivor’s life. Consequently, this case study includes multiple measures taken at 4- and 5-year follow-ups and represents the longest interval for which a stroke survivor receiving constraint-induced therapy has been followed.
Participant
We obtained information concerning this participant’s hospitalization, inpatient rehabilitation, and outpatient therapy in compliance with the Health Insurance Portability and Accountability Act of 1996. The participant was a 36-year-old, White, right-hand-dominant woman who sustained an ischemic infarct of the left internal capsule and the left basal ganglia. She was admitted to the hospital with acute onset aphasia and right-sided weakness. After 7 days, she was transferred to an inpatient rehabilitation facility where she received physical, occupational, and speech therapies for 15 days. Outpatient rehabilitation for all three therapies continued in a rehabilitation day program for 1.5 months after her discharge. Past medical history included treatment for migraine headaches, addressed depression (onset at age 14), two spontaneous vaginal deliveries, and a hysterectomy. She was enrolled at 19 months post–cerebral vascular accident.

The participant was a volunteer in the standardization process of a multisite randomized clinical trial (Winstein et al., 2003) evaluating constraint-induced therapy in subacute and chronic stroke survivors. Informed consent, as approved by a university institutional review board, was obtained before participation. Although too far poststroke to be included in the study, she did meet the study’s minimal movement criteria of the hemiplegic arm. Specifically, her right upper extremity was in Brunnstrom Stage IV–V (Brunnstrom, 1970) with predominantly isolated movement; active range of motion within functional limits for the shoulder, elbow, and wrist; and three-quarters range against gravity finger extension. Sensation and proprioception were intact. Functionally, she was independent in transfers and community ambulation and had no apparent aphasia or cognitive deficits (30/30 on the Mini-Mental State Examination; Folstein, Folstein, & McHugh, 1975). The participant was a full-time sales administrative assistant before sustaining a stroke and returned to the same job 3 months poststroke. She was married with two teenage children. She was chosen for this case study because her situation offered a unique opportunity to explore the long-term maintenance of the effects of constraint-induced therapy, and she was willing to undergo additional testing. Her motivation to improve function in her more-affected upper extremity was evident in her continued contact with this department over the 5-year period.

Method
The participant initially reviewed and signed a behavioral contract to wear a mitt on her less-affected hand for 90% of her waking hours for 14 consecutive days. The mitt was purchased from a well-known durable medical equipment supplier. It is sold as a padded safety mitt designed to prevent clients from pulling out catheters and IV tubes and other undesired behaviors. It is washable, latex free, and made of 100% cotton with a mesh covering with firm polyester filling. A hook-and-loop wrist strap secured the mitt at the wrist. The contract clarified appropriate times and activities during which the mitt was to be worn and specific safety precautions. The mitt could be removed for water-based activities, sleeping, driving, cooking, negotiating stairs, community ambulation, and bathroom activities. To ensure compliance with the wearing schedule, we used several behavioral techniques, including the behavioral contract, home diary, and daily schedule (see Winstein et al., 2003, for more details).

The participant trained individually with a rehabilitation specialist for an average of 5.5 hr each weekday. The rehabilitation specialist was an aide and a standardized constraint-induced therapy trainer in the EXtremity Constraint-Induced Therapy Evaluation (EXCITE; Winstein et al., 2003) national clinical trial who worked under the direct supervision of a physical therapist. Activities were chosen on the basis of the patient’s goals and movement limitations. Training focused on repetitive task practice and shaping of functional activities and included applying makeup, writing, typing, playing games with small pieces, and typical household chores, such as washing and drying dishes. Rest breaks were allowed when requested or needed because of shoulder pain and mental or physical fatigue. Each evening and on weekends, the patient was given tasks to perform that were designed to enhance practice of training activities. Examples of these activities included eating, playing games with her children, turning the pages of a magazine, and doing laundry.

Two evaluators administered standardized assessments to the participant 7 days before constraint-induced training (pretest), 10 days after constraint-induced training (posttest), and 4 and 5 years posttraining (follow-up). These assessments addressed levels of upper-extremity impairment with the Wolf Motor Function Test (WMFT; Wolf et al., 2001), functional levels with the Motor Activity Log (MAL; van der Lee, Beckerman, Knol, de Vet, & Bouter, 2004), and HRQOL levels with the Stroke Impact Scale (SIS; Duncan, Bode, Min Lai, Perera, & Glycine Antagonists in Neuroprotection Americans Investigators, 2003). See Winstein et al. (2003) for further description of these measurements. The evaluators were standardized evaluators in the EXCITE national clinical trial, and standardization was performed to ensure interrater reliability between EXCITE trial sites.

As was specifically described in Winstein et al. (2003), each evaluator was required to score 90% or better agreement with training core personnel on his or her standardization
videotape. This tape recorded their evaluation performance using the specified protocol and was compared with the criteria for the procedures. Both evaluators (a physical therapist and an occupational therapist) held clinical master’s degrees and had numerous years of clinical and research experience. They were not blinded to the participant’s treatment condition because the participant was a volunteer in the constraint-induced therapy standardization process.

Results

WMFT

The mean values for all 15 timed WMFT tasks (Table 1) indicate that the participant could perform faster after the intervention. Specifically, her average speed was faster at moving her forearm to the table (from the side), moving her forearm to a box (from the side), extending her elbow (from the side, with and without a 1-lb weight), moving her hand to the table (from the front), moving her hand to a box (from the front), reaching and retrieving a 1-lb weight, lifting a can, lifting a pencil, lifting a paperclip, stacking checkers, flipping cards, turning a key, folding a towel, and lifting a 3-lb basket (Table 2). The participant continued to show improvements in speed through the 4th year, with values increasing slightly in the 5th-year follow-up measurement but remaining better than at baseline and immediate posttesting. The participant could complete all tasks at each evaluation period, with the greatest amount of improvement seen primarily in fine motor functional tasks. The participant also showed large improvements in the WMFT “lift paperclip,” “stack checkers,” and “turn key in lock” tasks (i.e., decreased movement times; see Table 2) from pre- to posttesting that persisted to the 4- and 5-year follow-ups. There were also large improvements in “lift can,” “lift pencil,” and “lift basket” immediately after training that continued to improve after 4 years but slowed slightly at the 5-year follow-up. Varied and minimal changes were noted for shoulder strength with the “weight to box” task (12 lb pretest, 10 lb posttest, 14 lb 4-year follow-up, and 12 lb 5-year follow-up). Grip strength, however, consistently improved over time from an average of 15 kg at pretest to 18 kg at posttest and 20 kg at the 5-year follow-up. Equipment failure prevented 4-year follow-up data for grip strength.

SIS

Baseline values were relatively high (>80) for mobility, memory, emotion, communication, and social participation domains on the SIS (Table 3). Immediately posttreatment, improvements occurred in hand function, physical component score, mobility, and percentage of upper-extremity (stroke) recovery. At follow-up, improvements persisted for physically related measures and ADLs, whereas other domains, such as memory, emotion, and social participation, had varying results at different time points after intervention.

MAL

The MAL evaluation indicated improved use of the more-affected limb during daily functional activities. Figure 1 shows the average score (of all 30 functional items) on both the amount of use score and quality of movement portions. The amount of use score improved 2.7 points from very rare use (average pretreatment score = 1.18) of the more-affected limb to scores immediate posttreatment indicating that the participant used her limb more than half as much as she did before the stroke (average score = 3.83). The quality of movement scores also improved by 2.2 points, from 1.55 pretreatment to 3.75 posttreatment. These improvements declined at follow-up but remained higher than at baseline. More specifically, before training, the participant identified only 10 of 30 activities that she felt she could accomplish without the assistance of the stronger arm (a score of ≥3 on the MAL quality of movement portion). Immediately after training, she reported that she could perform 29 activities independently with her more-affected arm, the exception being buttoning a shirt. At Year 4, the number of tasks rated at ≥3 dropped to 22, and at Year 5 the participant identified only 21 items that could be accomplished without the assistance of the stronger arm.

Table 1. Distribution of Mean and Minimum–Maximum Times for Performance Times (in Seconds) on the Wolf Motor Function Test

<table>
<thead>
<tr>
<th>Tested Upper Extremity</th>
<th>Distribution</th>
<th>Pre-Tx</th>
<th>Post-Tx (Change Scores From Pre-Tx to Post-Tx)</th>
<th>4-Year Follow-Up (Change Scores From Pre-Tx to 4 Years)</th>
<th>5-Year Follow-Up (Change Scores From Pre-Tx to 5 Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>More affected</td>
<td>Minimum–maximum</td>
<td>1.21–7.49</td>
<td>1.17–6.74</td>
<td>0.89–5.49</td>
<td>0.77–7.90</td>
</tr>
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Note. Tx = treatment. Change scores between pretreatment and follow-up evaluations for mean distributions are in parentheses. Negative values indicate a decrease in amount of time taken to complete tasks (improved speed); positive values indicate an increase in amount of time taken to complete tasks (slower speed).
Participant Report

The participant reported changes in her personal life that occurred between posttreatment and the 4-year follow-up. Immediately after treatment, she continued to work full time and stated that she was able to incorporate her upper extremity more during secretarial tasks. However, she noted that despite performing in a dependable fashion at the workplace, her pace had slowed, and she fatigued more easily. Consequently, these limitations resulted in an overall poor work performance. Extreme fatigue caused her to curtail leisure activities to conserve energy so she could manage a full-time workload. Ultimately, even alternative part-time employment became too fatiguing, and subsequently she was unemployed between her 4th and 5th year after the stroke. However, during the 5th year of follow-up, she stated that the rest she experienced from not working combined with becoming a grandparent enhanced her socialization and motivated her to use her impaired upper extremity more frequently. There were no other reported treatment protocols for this participant during the 5 years after her constraint-induced therapy.

Discussion

After a 2-week period of constraint-induced therapy, this goal-directed individual with chronic stroke exhibited improvements in upper-extremity function that have persisted for 5 years. To date, we are unaware of other studies describing long-term follow-up with concomitant maintenance of motor improvements in the upper extremity after constraint-induced therapy. These improvements were evident in faster speeds with functional tasks, changes in hand function and ADL-related aspects of HRQOL, and reported use and ability of the arm and hand.

Immediately after training, the speed of the participant’s more-affected limb improved by 26%, and improvements were maintained throughout the follow-up period. These results are similar to those of Alberts, Butler, and Wolf.
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(2004), who found a 28% average change in WMFT scores after 2 weeks of constraint-induced therapy. The primary areas of improvement occurred almost exclusively in the functionally based fine motor tasks, such as lifting a paperclip, stacking checkers, or turning a key in a lock. More important, this individual already had a relatively fast mean baseline score of 3.27 s compared with an average baseline value of 18.74 s reported among the EXCITE trial’s higher-functioning group (Wolf et al., 2005); thus, a ceiling effect may have occurred.

The improvements in fine motor skills on the WMFT and the positive changes in the physical aspects of HRQOL (SIS domains of mobility, hand function, physical component score, and overall stroke recovery) seen immediately after constraint-induced therapy may reflect the functionally based, fine motor repetitive task practice focus of this upper-extremity intervention. The HRQOL domains of memory, emotion, and communication may not have shown immediate positive changes because they were not specifically targeted in the treatment.

Social participation demonstrated an unanticipated substantial drop after training (22 points). The specific questions in this domain relating to limitations in work, social, spiritual, and recreational activities worsened, whereas questions concerning connectedness to family and helping others in need stayed the same. This decline may have been a result of the intense training that prevented the participant from engaging in her regular social activities and work and may be a reason why patients have difficulty adhering to a constraint-induced therapy protocol.

After the 5-year follow-up, a lower score was also seen in the perceived hand function domain of the SIS. One explanation for this result may relate to the birth of and subsequent caregiving requirements for the participant’s first grandchild between Year 4 and 5, which motivated her to increase her use of the more-affected arm and hand. In so doing, she may have become more critical of the quality of movement. This finding possibility lends support to the notion that a life-changing event can affect one’s motivation and influence functional status.

Improvements persisted for physically related HRQOL measures, as demonstrated by the combined physical component score; however, worsening trends in HRQOL domains concerning memory, emotion, and social participation emerged at both 4- and 5-year follow-up periods. These results are comparable to those reported by Paul et al. (2005), who found that a large proportion of people 5 years poststroke suffered from poor HRQOL. Other studies (Ones, Yilmaz, Cetinkaya, & Caglar, 2005) have cited depression as the strongest predictor of HRQOL. Our participant did have a long-standing history of depression that may have affected many aspects of her life. Social participation scores at the 4- and 5-year follow-ups that improved but remained lower than baseline may reflect the participant’s change in work status to long-term disability during that time.

Comparisons of MAL low baseline scores for amount of use of the more-impaired limb to actual movement capabilities indicate that this participant exhibited the “learned non-use phenomena” (Taub, Uswatte, & Pidikiti, 1999, p. 239). Although she had adequate motor capabilities for most functional tasks, she did not report actually attempting to use the limb more than occasionally or very rarely for daily activities. It is difficult to ascertain whether the slight decline in long-term follow-up was the result of a deliberate decision not to perform tasks with the affected arm or of physical inability to do so. Immediate posttreatment outcomes indicate that constraint-induced therapy could have affected improvement in the amount of limb use. These positive results, along with improvements in the WMFT, are consistent with previous findings in patients with chronic stroke.

The long-term maintenance of the improved use of the limb showed some decline, but the outcome measures suggested that most improvements were maintained above baseline levels. In general, marked improvements immediately after training for the WMFT, MAL, and physical aspects of the SIS appeared to continue more gradually over 5 years. This tapering effect suggests that periodic episodes of continued training to further exploit possible improvements in function may be worthwhile. Bonifer, Anderson, and Arciniegas (2005) suggested that people with moderate to severe upper-extremity impairments may benefit from several applications of constraint-induced therapy or participation in periodic constraint-induced therapy maintenance sessions. Considering the multidimensional and chronic effects of stroke, the application of rehabilitative intervention booster sessions seems reasonable. However, the fact that improvements were largely maintained without booster sessions lends additional support to the potential effectiveness of constraint-induced therapy over the long term.

Throughout the long-term follow-up, the participant reported severe fatigue as her most disabling symptom, contributing to limitations in work, leisure, and self-care more than did the actual impaired use of her right hand. This poststroke symptom had a substantial effect on her long-term earning potential and quality of life. Fatigue is a frequent and disabling poststroke sequela, affecting 57% to 68% of stroke survivors between 3 and 15 months after onset. Of patients 3 to 13 months poststroke, 40% reported that fatigue was either their worst or one of their worst symptoms (Ingles, Eskes, & Phillips, 1999). Despite the maintenance of improvements in upper-extremity movement and function after constraint-induced therapy, the
intervention did not affect her overriding complaint of fatigue, which apparently limited her work productivity and family enjoyment. Therefore, more specific measures and treatments for fatigue after stroke are warranted.

In summary, this case study lends support for the maintenance of upper-extremity improvements over several years after constraint-induced therapy. Although these findings suggest that elements of this intervention can affect a successful rehabilitation experience, the question still remains as to whether additional booster sessions of constraint-induced therapy would have proven to be cost effective in maintaining this participant’s earning capacity and overall quality of life. Additionally, the overriding factor of this participant’s fatigue, and its apparent influence on all measures, could have limited the benefits derived from constraint-induced therapy.

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References


