

Case Study

Effects of modified constraint-induced movement therapy and functional bimanual training on upper extremity function and daily activities in a patient with incomplete spinal cord injury: a case study

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Abstract. [Purpose] In this study, we examined effects of modified constraint-induced movement therapy (m-CIMT) and functional bimanual training, when applied to a patient with incomplete spinal cord injury, on upper extremity function and daily activities. [Subject and Methods] One patient, diagnosed with C4 incomplete spinal cord injury, underwent physical therapy with constraint-induced movement therapy for 3 hours and task-oriented bimanual training for 1 hour, per day. This combined 4-hour session was performed five times a week, for 3 weeks, totaling 15 sessions. Upper extremity function was measured using the Manual Function Test (MFT) and Box & Block Test (BBT). Additionally, Spinal Cord Independence Measure Version III (SCIM-III) and Short Form 36 Health Survey (SF-36) were used to assess functional outcomes. [Results] Mobility of the hand and overall function of upper extremities were enhanced following intervention. Moreover, the subject's quality of life and ability to carry out daily activities also improved. [Conclusion] Modified constraint-induced movement therapy and bimanual training was effective in enhancing upper extremity function and performance of daily routines in a patient with incomplete spinal cord injury. Further studies, recruiting multiple subjects, should focus on m-CIMT using diverse methods, performed during the course of daily activities.

Key words: Incomplete spinal cord injury, Modified constraint-induced movement therapy, Upper extremity function

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INTRODUCTION

Incomplete spinal cord injury (SCI) is characterized by partial functional loss, with varying degrees of voluntary motor and sensory functions remaining in the three segments below the injury at a neurological level^{1, 2)}. The majority of patients with incomplete SCI showed impaired upper extremity function due to damage in motor and sensory, decreasing the ability to perform independent daily activities and, concomitantly, quality of life³⁾. Constraint-induced movement therapy (CIMT)⁴⁾ is a rigorous training method, designed to improve function of the upper extremities by exploiting neural plasticity⁵⁾. CIMT is the preferred treatment for stroke patients, in addition to those with diverse diseases, including cerebral palsy, hip joint fracture, and incomplete SCI.

Nevertheless, original CIMT protocols are problematic

to implement, due to physical and psychological pressures resulting from a 6-hour usage restriction on unaffected upper extremities. As a result, the modified CIMT (m-CIMT) protocol was developed^{6, 7)}. To preserve and enhance effects of m-CIMT on the function of the upper extremities, subjects are emphasized the necessity of using both hands and encouraged to do so in their daily activities⁸⁾.

This study applied m-CIMT, developed to treat patients with neurological repercussions of stroke, to a subject with incomplete SCI as a method of promoting mobility of an upper extremity exhibiting impaired function. Moreover, this study aimed to enhance performance of daily activities and overall quality of life for the subject, through functional bimanual training.

SUBJECT AND METHODS

The subject was a 35-year-old patient with an incomplete central SCI (tetraplegia, C6/C6(m) C4/C4(s) ASIA-D), hospitalized in a rehabilitation facility. The incomplete central cord syndrome was diagnosed by a specialist and exhibited mobility differences between functions of the left and right upper extremities. Before participation, the procedures, risks, and potential benefits were explained to the participant, who provided informed consent. The par-

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participant's rights were protected according to the guidelines established by the University of Hanseo. The subject was capable of holding and putting down objects using the hand with weaker function (left) (i.e., capable of at least 20° rotation in wrist adduction and flexion condition and at least 10° rotation of the metacarpophalangeal and carpal bone joints). The subject had no cognitive damage, as evidenced by a Korean Mini-Mental State Examination (MMSE-K) score of 29, and was capable of independent walking. The intervention was implemented for 4 hours a day, comprising m-CIMT for 3 hours combined with functional bimanual task training for 1 hour, five times a week, for 3 weeks. For m-CIMT, the subject wore a mitten on the unaffected (right) side to restrict movement and performed daily activity tasks through exclusive use of the affected (left) side. Functional bimanual task training was performed in a treatment room for 1 hour following m-CIMT, five times a week. During this process, daily activities were performed with an emphasis on using both affected and unaffected upper extremities simultaneously. The bimanual task training consisted of pouring water in a glass, fastening a button, putting on or removing a shirt, folding towels, and wiping windows. To assess function of the upper extremities, the performance of daily activities, and quality of life before and after training, the Manual Function Test (MFT), Box & Block Test (BBT), Spinal Cord Independence Measure Version III (SCIM-III), and Short Form 36 Health Survey (SF-36) were used.

RESULTS

The MFT score of the affected upper extremity increased from 28 before the intervention to 30 following the intervention. The BBT score increased from an average of 47.7 before the intervention to 54 after the intervention. The SCIM-III score increased from 95 to 97 after the intervention, with an increase of one score in each of bathing (upper body) and outdoor movement (over 100 m). The SF-36 score increased by 3 points from 74 to a total of 77 following the intervention.

DISCUSSION

Through exclusive use of the subject's affected side, in combination with bimanual task training, this study aimed to observe an improvement in the functional ability of the affected upper extremity in a patient with an incomplete SCI. Results suggest enhanced upper extremity mobility following intervention, with a positive outcome for the patient's quality of life and performance of daily activities. These results are consistent with observations of improved upper extremity function following application of m-CIMT to patients with neurological insufficiencies as a result of stroke⁹⁾. Studies of CIMT have previously focused on patients with stroke or children with cerebral palsy, with limited research on patients with spinal cord damage. In general, active use of the affected extremities in daily life is necessary to generalize the effects of CIMT, and CIMT reduces the gap between

the existing performance and functional levels of patients. Notwithstanding, the CIMT protocol presents problems in that it limits posture balance and daily activities for some time with restriction on use of the unaffected side. To alleviate this problem, the subject in this study was required to perform functional bimanual task training for 1 hour after applying the m-CIMT protocol for 3 hours, to complement functional aspects of the unaffected side. Most studies have reported a greater increase in favorable outcomes when applying bimanual training in the rehabilitation process of the upper extremities. In part, this facilitates recovery of the ability to carry out daily activities correctly, since most independent daily activities require bilateral coordination^{10, 11)}.

This study had limitations. General m-CIMT protocol involves 2-hour daily intensive training on the affected side, with a 6-hour restriction on the use of the unaffected side¹²⁾. This study limited the use of the subject's unaffected side to only 3 hours, accommodating the hospitalized patient's characteristics. Moreover, the use of only a single subject means the results cannot be generalized. Future research is required to ascertain whether observed changes in the function of upper extremities and quality of life hold consistent with larger test groups and more rigorous training protocols.

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